June 2007

Final

Vegetation Treatments

on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report

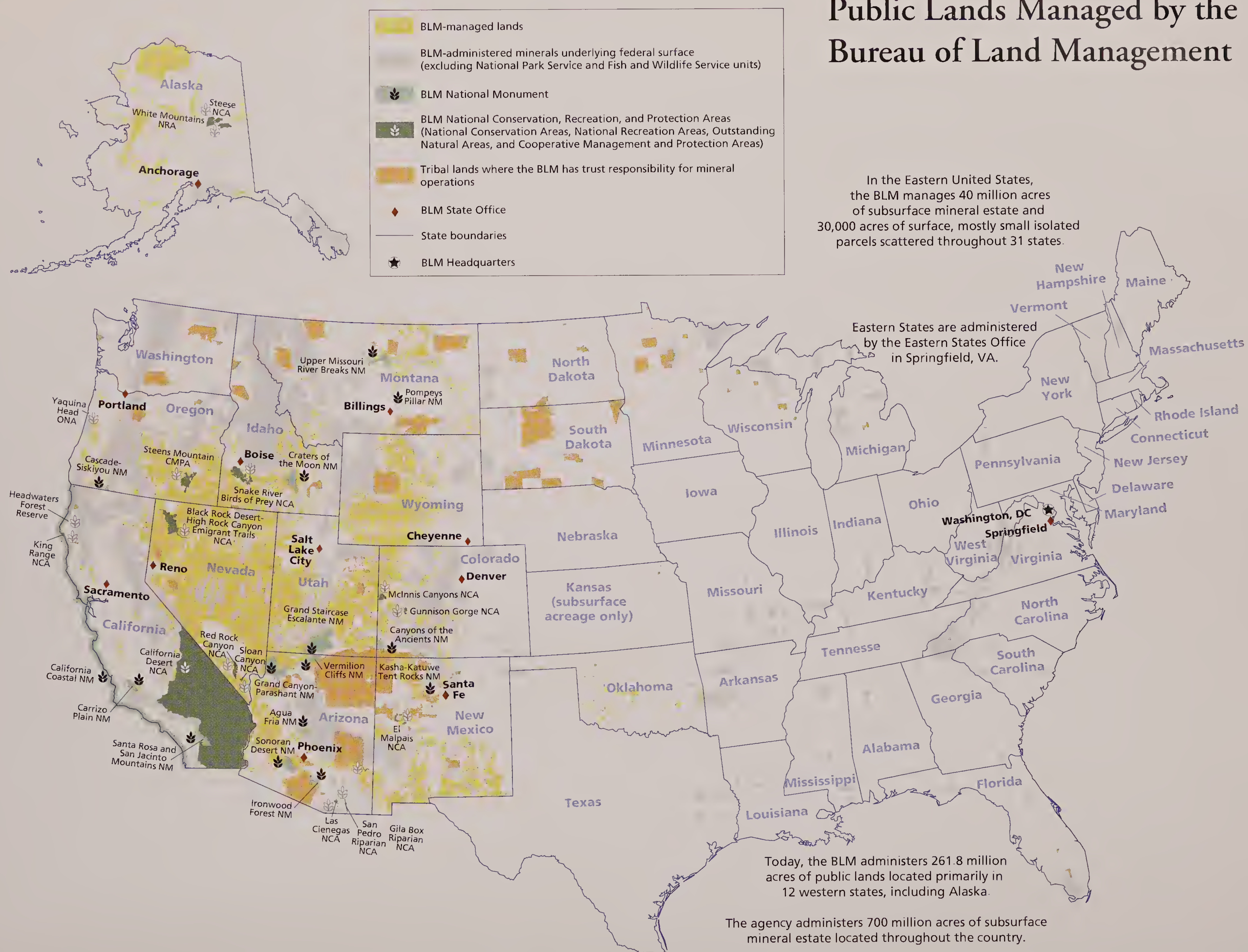
Abstract, Executive Summary, Chapters 1 through 7, and Appendixes

U.S. Department of the Interior
Bureau of Land Management

FES 07-21

BLM

Public Lands Managed by the Bureau of Land Management



In the Eastern United States, the BLM manages 40 million acres of subsurface mineral estate and 30,000 acres of surface, mostly small isolated parcels scattered throughout 31 states.

Eastern States are administered by the Eastern States Office in Springfield, VA.

Today, the BLM administers 261.8 million acres of public lands located primarily in 12 western states, including Alaska.

The agency administers 700 million acres of subsurface mineral estate located throughout the country.

Final Programmatic Environmental Report

Vegetation Treatments on Bureau of Land Management Lands in 17 Western States

Prepared by

Bureau of Land Management
Nevada State Office
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June 2007

EXECUTIVE SUMMARY

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Introduction

The Bureau of Land Management (BLM), an agency of the U.S. Department of the Interior (USDI), manages vegetation on nearly 261 million acres (public lands) in 17 states in the western U.S., including Alaska. Management and control of vegetation on public lands for resource and habitat enhancement is an important function of this agency, including management to reduce the risk of wildfires to people and their property. Management and control of vegetation for resource and habitat enhancement is accomplished using a variety of treatment methods, including, but not limited to: herbicides, prescribed fire and wildland fire use for resource benefit (collectively termed "fire use"), manual and mechanical methods, and biological controls such as insects, pathogens, and domestic grazing animals.

The BLM is proposing to increase the number of acres of vegetation treated annually from approximately 2 million to 6 million. Treatments would occur in 17 western states in the U.S., including Alaska. The action would reduce the risk of catastrophic wildfires by reducing hazardous fuels, restoring fire-damaged lands, and improving ecosystem health by 1) controlling weeds and invasive species; and 2) manipulating vegetation to benefit fish and wildlife habitat, improve riparian and wetland areas, and improve water quality in priority watersheds.

This *Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report* (PER), discloses the general effects on the environment of using non-herbicide treatment methods, including fire use, and mechanical, manual, and biological control methods, to treat hazardous fuels, invasive species, and other unwanted or competing vegetation.

A separate *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (PEIS) analyzes the effects of herbicide use on humans, plants, animals, and other environmental and social resources associated with public lands. The PEIS analysis provides the basis for a programmatic Endangered Species Act (ESA) Section 7 consultation with the U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration National Marine Fisheries Service on the potential effects of treatments on plant and animal special status species.

Background

In recent years, the severity and intensity of wildfires in the West has increased dramatically from levels in the 1970s and 1980s; currently, a million or more acres burn annually. Changes in the vegetation on public lands have resulted in increases in hazardous flammable fuels.

Much of the increase in hazardous fuels can be attributed to fire exclusion policies over the past 100 years. Contributors to the change include intermittent and long-term drought over the past 40 years and an increase in the spread of noxious weed species and other invasive vegetation. Invasive species are the dominant vegetation on an estimated 35 million acres of public lands. The estimated rate of weed spread on western public lands in 1996 was 2,300 acres per day. Invasive vegetation and noxious weeds degrade or reduce soil productivity, water quality and quantity, native plant communities, wildlife habitat, wilderness values, recreational opportunities, and livestock forage, and are detrimental to the agriculture and commerce of the U.S. and to public health. Weed infestations can become permanent if left untreated.

In response to the threats of wildfire and invasive species, the President and Congress have directed the USDI and BLM, through implementation of the *National Fire Plan*, and the *Healthy Forests Restoration Act of 2003*, to take more aggressive actions to reduce catastrophic wildfire risk on public lands. The actions would be taken to protect life and property, and to manage vegetation in a manner that provides for long-term economic sustainability of local communities, improved habitat and vegetation conditions for fish and wildlife, and other public land uses.

The BLM last assessed its use of vegetation treatment methods during the late 1980s and early 1990s, by preparing Environmental Impact Statements (EISs) and Records of Decision (RODs) that covered vegetation treatment activities in 14 western states in the continental U.S. These EISs evaluated the

environmental impacts associated with vegetation control and modification from use of herbicides, in addition to other treatment methods—manual, mechanical, and biological control methods, and use of fire on approximately 500,000 acres of public lands a year in the western U.S. The EISs also evaluated the risks to human health and non-target species associated with using 20 herbicide active ingredients on these public lands.

To maintain and improve the effectiveness of its vegetation management practices, this PER supports the BLM's intent to continue to use, and increase the use of, a variety of fire and non-fire treatment methods to reduce hazardous fuels, control unwanted vegetation, and improve habitat and resource conditions. These actions will be accomplished primarily through the proactive use of herbicides, prescribed fire, wildland fire for resource benefit, manual and mechanical methods, and biological controls that have been approved for use on public lands through previous EIS Records of Decision addressing vegetation control.

Program Objectives and Goals

The goals of vegetation management are to sustain the condition of healthy lands, and, where land conditions have degraded, to restore desirable vegetation to more healthy conditions. Eventually, the number of acres needing treatment should be reduced as a result of overall improvement in conditions.

Concurrently, public lands must be administered under the principles of multiple use and sustained yield in accordance with the intent of Congress as stated in the Federal Land Policy and Management Act of 1976 (FLPMA). Thus, vegetation must be managed to protect and enhance the health of the land while providing a source of food, timber, and fiber for domestic needs. Land-disturbing activities must be conducted in a manner that minimizes ecosystem fragmentation and degradation, and lands should be rehabilitated, when necessary, to safeguard the long-term diversity and integrity of the land.

The BLM is increasing the number of acres treated annually from nearly 2 million up to 6 million to respond to Presidential and Congressional mandates to reduce the risk of wildfire by reducing the occurrence of hazardous fuels, especially in the wildland urban interface, restoring fire-adapted ecosystems, and repairing lands damaged by fire. Public lands that are subject to these mandates total about 5 million acres annually. The remaining 1 million acres would be treated based on the needs of other programs within the BLM.

When developing treatment objectives on the national and local level, the BLM will 1) take actions to prevent or minimize the need for vegetation controls, where feasible; 2) use effective non-chemical methods of vegetation control, where feasible; and 3) use herbicides only after considering the effectiveness of all potential methods.

The overriding goal is to restore desirable vegetation on lands only when it is necessary, and to prioritize treatment methods based on their effectiveness and the likelihood that they will have minimal effects on the environment.

Actions to prevent or minimize the need for vegetation control could include protecting intact systems; maintaining conditions that have led to healthy lands (e.g., allowing natural fires to burn); allowing natural processes to restore lands; reducing the effect of ongoing activities (e.g., improving grazing management practices); and applying mitigation measures to new projects to minimize soil and vegetation disturbance and avoid introduction of invasive species.

Acres to be treated by the BLM and assessed in this PER were estimated based on information provided by BLM field offices. Each field office was asked to estimate and summarize proposed vegetation treatment projects likely to occur during the next 10 years. For each project, the field office provided an estimate of the number of acres proposed for treatment, the general vegetation type(s) proposed for treatment, and the vegetation treatment method(s) proposed to be used.

Based on this estimate, approximately 3.5 million acres would be treated annually to reduce hazardous fuels, 1.5 million acres to restore and revegetate lands burned by wildfires or damaged by weed and other invasive species, and 1 million acres to meet other agency objectives, including improving fish and wildlife habitat and watershed processes. Mechanical treatments would be used on approximately 2.2 million acres, fire use on 2.1 million acres, herbicides on 932,000 acres, biological control on 454,000 acres, and manual treatments on 271,000 acres annually.

The BLM would follow standard operating procedures, based on BLM guidelines that currently exist in policy, manuals, or handbooks, to ensure that vegetative treatment actions are effective. These procedures include using prevention and early detection to minimize weed problems in the future and revegetating treatment sites. In addition, the BLM would follow standard industry practices, including using equipment in proper working order, wearing protective clothing, and following label directions when applying herbicides.

The BLM would monitor vegetation treatments so that treatment outcomes could be measured, evaluated, and used to guide future treatment actions. These steps would ensure that vegetation treatment processes would be effective, adaptive, and based on prior experience.

The BLM would foster collaborative relationships with stakeholders, including individuals, communities, and governments. This collaboration would improve communication and help the BLM develop a greater understanding of different perspectives and find solutions to issues and problems. The BLM would also follow the National Environmental Policy Act (NEPA) process to ensure that the public is allowed input into vegetation management actions on public lands.

Effects of Treatments

The direct and indirect effects of treatments on natural and socioeconomic resources are evaluated in this PER. The effects of using herbicides, and cumulative effects that result from the incremental effect of treatment actions when added to the effects of other past, present, and reasonably foreseeable future actions, are discussed in more detail in the PEIS.

Direct and Indirect Effects

Treatments would contribute only minor amounts of pollutants to the air. Fire use would increase particulate matter in the air, but the amount of pollutants generated by fire use, and their effects on human health, should be less than those from wildfire, resulting in fewer pollutants accumulating than would occur without treatments. None of the treatments would result in emissions that exceed Prevention of Significant Deterioration thresholds or National Ambient Air Quality Standards.

Treatments would lead to the short-term loss of soil due to removal of vegetation and erosion. None of the herbicides commonly used, or proposed for use, by the BLM appears to result in adverse effects to soil. Treatments would benefit soil by restoring natural fire regimes and slowing the spread of weeds, which should reduce soil erosion and improve soil productivity over the long term.

Treatments that lead to erosion could result in poorer water quality on portions of public lands. Several herbicides used, or proposed for use by the BLM, are known groundwater contaminants. Effects to surface water would be minor, and herbicide concentrations in surface water should not exceed safe levels for human health. Treatments would improve watershed function and water quality, since many treatments would be targeted for watersheds where water quality does not meet state or tribal standards.

Treatments could adversely affect non-target vegetation and accidental spills of herbicides and herbicide drift from treatment areas could be particularly damaging to non-target vegetation. Treatments that lead to erosion and loss of vegetation could harm wetland and riparian area functions and values. Treatments would help to control aquatic vegetation that chokes waterways and affects wetland function and values. Upland, wetland, and riparian area treatments that restore native vegetation would help to control weeds and other vegetation to reduce the risk of catastrophic fire and improve ecosystem health.

Treatments could cause injury or mortality to fish and wildlife, alter or destroy habitat, and disturb animals, thereby affecting their behavior or habitat use. Fish and wildlife could also forage on vegetation that has been treated, or prey on other animals that have been exposed to herbicides, and be harmed. All of the herbicides pose some risk to non-target terrestrial and aquatic vegetation; damage to these plants could adversely affect habitats used by fish and wildlife. Long-term improvement in vegetation characteristics would benefit fish and wildlife. Some species that have adapted to degraded ecosystems could lose habitat as native vegetation was restored, but most species would benefit.

Treatments that cause the short-term loss of forage and other vegetation needed by livestock and wild horses and burros could harm these animals. Livestock and wild horses and burros could be affected by herbicides from an accidental spill, direct spray, herbicide drift,

or by consuming herbicide-treated vegetation; these risks would be negligible to minor. Treatments should improve rangelands for these animals, and ensure that public lands can support viable populations of wild horses and burros and a healthy ranching industry.

While treatments could affect cultural or paleontological resources near or on the surface, they would be more likely to affect traditional cultural practices of gathering plants and the health of Native peoples. Cultural and paleontological resources could be directly affected primarily from fire use and mechanical and herbicide treatments. Native peoples could be at risk from harvesting plants treated with herbicides, or from direct exposure to herbicide spray. However, the BLM would use herbicides that are generally safe for use around people, and would conduct pre-treatment surveys to identify areas of cultural concern before conducting treatments to reduce the loss of these values.

Treatments could affect visual, wilderness, and recreation resources. Treatments would remove and discolor vegetation, making it less visually appealing. Over the long term, landscapes should be more appealing as native vegetation was restored. Treatments in wilderness and other special areas would detract from the “naturalness” of the area. Use of mechanical equipment would create noise and reduce the wilderness experience, although it would be strongly discouraged in these areas. Recreationists could be exposed to herbicides, experience less visually-appealing landscapes, or find fish and game less plentiful as a result of treatments. In addition, recreational areas could be closed for short periods of time after treatment to ensure treatment success and protect the health of visitors. However, these effects would be short term and any values affected would be restored within two growing seasons in most cases.

Social effects would be minor at the scale addressed in the PER. There would be benefits to communities that supply workers, materials, or services in support of treatment activities. Some businesses, such as recreation-based businesses and ranching operations, could be adversely affected if treatments closed areas used for recreation or by domestic livestock. There are potential environmental justice concerns because a large number of Native peoples and other minority groups live in the West and work in industries (e.g., forest products, herbicide application) or conduct activities (e.g., gathering of plants for traditional uses, recreation) that could potentially expose these groups to treated areas. Treatments would benefit local communities by providing jobs and income, and by reducing the risk of catastrophic wildfire that could harm people and destroy property.

Treatments could harm the health of workers and the public, primarily from the use of herbicides. Most herbicides, however, would pose few risks to workers, and even fewer risks to the public, when applied at the typical application rate. New herbicides proposed for use pose few or no risks, except for diquat. If treatments restored natural fire regimes, reduced the risk of catastrophic fire, and slowed the spread of weeds, human health would benefit. To reduce risks to the public, treatments would take into consideration the proximity of the treatment site to nearby residential, commercial, and traditional use areas. For example, mechanical treatments might be used instead of fire or herbicides near homes to reduce the risk of public exposure to smoke and herbicide drift.

Summary

All treatments would have short-term effects on resources, and in some cases non-target resources, ranging from negligible or minor to adverse, depending on the resource affected, timing, duration, proximity and location. Treatments that remove hazardous fuels from public lands would be expected to benefit the long-term health of plant communities in which natural fire cycles have been altered. The suppression of fire results in the buildup of dead plant materials (e.g., litter and dead woody materials), and often increases the density of flammable living fuels on a site. Treatments that restore and maintain fire-adapted ecosystems, through the appropriate use of mechanical thinning, fire use, and other vegetation treatment methods, would decrease the effects of wildfire on plant communities and improve ecosystem resilience and sustainability. Treatments should also reduce the incidence and severity of wildfires across the western U.S.

Treatments that control populations of non-native species on public lands would be expected to benefit native plant communities over the long term by aiding in the reestablishment of native species. The degree of benefit would depend on the success of these treatments over both the short and long term. Some treatments are very successful at removing weeds over the short term, but are not successful at promoting the establishment of native species in their place. In such cases, seeding and planting of native plant species would be beneficial.

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CHAPTER 1

PURPOSE OF THE ENVIRONMENTAL REPORT

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CHAPTER 1

PURPOSE OF THE ENVIRONMENTAL REPORT

Introduction

The Bureau of Land Management (BLM), an agency of the U.S. Department of the Interior (USDI), manages vegetation on nearly 261 million acres in 17 states in the western U.S., including Alaska (pubic lands; treatment area; Map 1-1). These lands encompass approximately 1 out of every 5 acres from the Rocky Mountains to the Pacific Ocean. Management and control of vegetation for resource and habitat enhancement is accomplished using a variety of treatment methods, including, but not limited to: herbicides, prescribed fire and wildland fire use for resource benefit (collectively termed “fire use”), manual and mechanical methods, and biological controls such as insects, pathogens, fish, and domestic grazing animals.

In recent years, the severity and intensity of wildfires in the West has increased dramatically from levels in the 1970s and 1980s. Although the recent increase in wildfires is directly related to drought conditions throughout the western U.S., it is also influenced by changes in the vegetation on public lands that have occurred during the past 50 years and have resulted in increases in hazardous flammable fuels. As the population has increased in the western U.S., the loss of life and property has also increased as more people live in close proximity to public lands in areas now referred to as the wildland urban interface (WUI).

Much of the change in vegetation and increase in hazardous fuels on public lands can be attributed to fire exclusion policies over the past 100 years. Contributors to this change include natural influences, such as intermittent and long-term drought over the past 40 years. They also include anthropogenic influences, such as alteration of vegetation and habitat at the local and landscape levels through authorized uses on public lands (e.g., livestock grazing and timber management), full fire suppression policies to protect infrastructure and vegetative resources, and the increased spread of noxious weed species and invasive vegetation.

Some noxious weeds and other invasive vegetation, such as downy brome[1] (also known as cheatgrass), act as hazardous fuels in upland landscapes. Downy brome is a self-perpetuating winter annual that spreads easily across upland landscapes altered by fire, through a prolific seed source. Wind and soil erosion transport the seed over wide areas and into previously undisturbed habitats.

Invasive vegetation and noxious weeds are highly competitive and can often out-compete native vegetation, especially on recently disturbed sites. Invasive vegetation and noxious weeds are the dominant vegetation on an estimated 35 million acres of public lands (USDI BLM 2000a). The estimated rate of weed spread on western public lands in 1996 was 2,300 acres per day (USDI BLM 1996). Invasive vegetation and noxious weeds degrade or reduce soil productivity, water quality and quantity, native plant communities, wildlife habitat, wilderness values, recreational opportunities, and livestock forage, and are detrimental to the agriculture and commerce of the U.S. and to public health (National Academy of Sciences 1968, USDI BLM 2000b). Weed infestations can become permanent if left untreated.

In response to the threats of wildfire and invasive vegetation and noxious weeds, the President and Congress have directed the USDI and BLM, through implementation of the *National Fire Plan* (USDI and U.S. Department of Agriculture [USDA] Forest Service 2001), and the *Healthy Forests Restoration Act of 2003*, to take more aggressive actions to reduce catastrophic wildfire risk on public lands. The actions would be taken to protect life and property, and to manage vegetation in a manner that provides for long-term economic sustainability of local communities, improved habitat and vegetation conditions for fish and wildlife, and other public land uses. As a result of these actions, the amount of hazardous fuels reduction and other

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[1] Common and scientific names of plants and animals given in this PER are provided in Appendix A.

vegetation management work conducted by the BLM is expected to increase from current levels to about 6 million acres annually.

The BLM last assessed its use of vegetation treatment methods during the late 1980s and early 1990s, by preparing Environmental Impact Statements (EISs) and Records of Decision (RODs) that covered vegetation treatment activities in 14 western states in the continental U.S. (all states shown on Map 1-1, except Alaska, Nebraska, and Texas; USDI BLM 1985; 1987a, b; 1988a, b; 1989; 1991a, b; 1992a). The previous EISs primarily focused on vegetation control of competing and unwanted vegetation for resource enhancement (forestry and rangelands), noxious and invasive weed control related to surface use activities (oil and gas, rights-of-way [ROW]), and reduction of hazardous fuels to protect resources at risk from wildfire damage. These EISs evaluated the environmental impacts associated with vegetation control and modification on approximately 500,000 acres of public lands a year in the western U.S. The EISs also evaluated the human health and non-target species risks of using 22 herbicide active ingredients (a.i.) on these public lands.

Organization of the Vegetation Treatments Assessments

The BLM's assessment of vegetation treatment activities on public lands consists of two interrelated parts—this *Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report* (PER), which evaluates the effects of non-herbicide vegetation treatments, and a *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (PEIS; USDI BLM 2007a), which analyzes the impacts of using herbicides on public lands. This organization was selected because the primary issue of controversy identified through scoping, and which required National Environmental Policy Act (NEPA) review, was the BLM's continuing and proposed increase in the use of herbicides in vegetation treatment programs needed to implement the *National Fire Plan* and related initiatives. The use of herbicides has been affirmed as a central issue for analysis in all past EISs.

The use of the other non-herbicide techniques in an integrated pest management approach has been affirmed in all previous EISs Records of Decision, and the BLM will continue to use non-herbicide vegetation treatment methods.

Terminology

Active ingredient (a.i.) is the chemical or biological component that kills or controls the target pest.

Fire use a term not used in federal fire policy. It is used in the context of the PEIS/PER to refer to prescribed fire or wildland fire use to meet resource objectives.

Hazardous fuels include living and dead and decaying vegetation that form a special threat of ignition and resistance to control.

Herbicide is a chemical pesticide used to treat vegetation.

Invasive plants are plants that are not part of (if exotic), or are a minor component of (if native), the original plant community or communities that have the potential to become a dominant or co-dominant species on the site if their future establishment and growth are not actively controlled by management interventions, or are classified as exotic or noxious plants under state or federal law. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants.

Native species historically occurred or currently occur in a particular ecosystem and were not introduced.

Noxious weeds are designated by federal or state law as generally possessing one or more of the following characteristics: aggressive and difficult to manage; parasitic; a carrier or host of serious insects or disease; or non-native, new, or not common to the U.S.

Prescribed fires are any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and NEPA requirements (where applicable) must be met, prior to ignition.

Undesirable plants are species classified as undesirable, noxious, harmful, exotic, injurious, or poisonous under state or federal law, but not including species listed as endangered by the Endangered Species Act (ESA), or species indigenous to the planning area.

Weeds are plants that interfere with management objectives for a given area at a given point in time.

Wildfires are unplanned, unwanted wildland fires including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out.

Wildland fires are any non-structure fires that occur in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire use, and prescribed fire.

Wildland fire use fires are the application of the appropriate management response to naturally-ignited wildland fires to accomplish specific resource management objectives in pre-defined designated areas outlined in Fire Management Plans.

Wildland urban interface (WUI) is an area where structures and other human development intermingle with undeveloped wildlands or vegetative fuels.

Although more acres are proposed for treatment under all methods than were identified in previous EISs, the BLM has determined that additional analysis of treating these acres under non-herbicide methods in the PEIS is unnecessary. Congress and the Administration made the decision for federal agencies to treat more acres to reduce the threat of catastrophic fire. The PEIS and PER broadly estimated the acres that could be potentially treated under each method for analysis purposes in the PEIS. The acre totals used in the programmatic analysis are not site-specific as to locations or method(s) used. As identified below in Chapter 2, current land use plans guide the level of treatment activity necessary to meet broad goals and objectives for vegetation. It is anticipated that acres identified for treatments in land use plans and step down activity level plans would be modified in the future as they are revised or amended to reflect the increase in activity mandated by Congress, and that those plans will provide the necessary NEPA analysis to support increased acres of treatment.

Treatment of vegetation is not a static disturbance that accumulates over time. Vegetation treatments are dynamic and typically show results within the first 2 growing seasons. Once vegetation objectives are met, the projects are maintained over time, resulting in viable and resilient vegetation communities over the long term. As more acres are treated, more acres of vegetation meet management objectives as outlined in local land use plans. Projects implemented over the last 10 to 20 years typically have met their objectives and become part of the baseline for analysis of new projects. Because of this dynamic continuum of treatment, revegetation, monitoring, and maintenance, the BLM does not anticipate there would be any different or significant impacts identified beyond what has been analyzed in previous EISs.

This PER discloses the general effects on the environment of using non-herbicide treatment methods, including fire use, and mechanical, manual and biological control methods, to treat hazardous fuels, invasive species, and other unwanted or competing vegetation.

The PEIS analyzes the effects of herbicide use on humans, plants, and animals and other environmental and social resources associated with public lands. This analysis will provide the basis for a programmatic Endangered Species Act (ESA) Section 7 consultation with the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) on herbicide use, and the potential impacts of herbicide use on plant and animal species of concern.

The PEIS provides an updated analysis of impacts (direct, indirect, and cumulative) to public land environmental and socioeconomic resources from proposed vegetation treatment activities utilizing herbicides. The PER is linked to the PEIS in the cumulative impact analysis of the PEIS, where all methods of treatment, including the use of herbicides, are assessed.

Program Objectives and Goals

To maintain and improve the effectiveness of its vegetation management practices, this PER supports the BLM's intent to continue to use, and increase the use of, a variety of fire and non-fire treatment methods to reduce hazardous fuels, control unwanted vegetation, and improve habitat and resource conditions. These actions will be accomplished primarily through the proactive use of herbicides, prescribed fire, wildland fire for resource benefit, manual and mechanical methods, and biological controls that have been approved for use on public lands through previous EISs addressing vegetation control.

This PER provides BLM field offices with information needed to 1) assess and reduce the risk of catastrophic wildfires on public lands and in the WUI; 2) slow the spread of invasive plant species noxious weeds, and other unwanted, undesirable, or competing vegetation (unwanted vegetation); 3) improve ecosystem health by restoring fire-adapted ecosystems; 4) identify and implement best management practices; and 5) understand cumulative effects of treatment activities.

Background

Today, more than 63 million people live in the western U.S., and growth rates in 9 western states exceeded 20% or more during the past decade. As growth continues, there is also an increasing demand from the public to protect and preserve clean air and water, open space, and habitat for threatened and endangered species. This dramatic growth in the human population has placed increasing demands on the BLM to manage its resources to meet human needs while protecting the environment and maintaining the health of the land.

In recent years, the severity and intensity of wildfires in the West has increased dramatically from levels in the 1970s and 1980s. The 2004 fire season was one of the

worst fire seasons on record, with over 3.6 million acres of public lands burned by wildfires (Figure 1-1). Although the recent increase in wildfires is directly related to drought conditions throughout the West, it is also influenced by changes in the vegetation on public lands that have occurred during the past 100 years and have resulted in increases in hazardous flammable fuels. With the concurrent population growth in the western U.S., the loss of life and property has also increased as more people live in close proximity to public lands in the WUI.

Western U.S. forests have experienced significant changes in vegetation and structure over the past century. Over the last 50 years, the BLM and other federal agencies with wildland fire responsibilities put out wildfires as quickly as possible to protect life and property. This practice, referred to as "full suppression," has resulted in long-term fire exclusion from landscapes historically adapted to fire. In forested ecosystems, severe wildfires kill large, old trees that have survived multiple fires in the past and, in many cases, provide the seed necessary to regenerate the forest. They also remove important ground cover, which leaves these areas exposed to severe erosion and the invasion of exotic plant species.

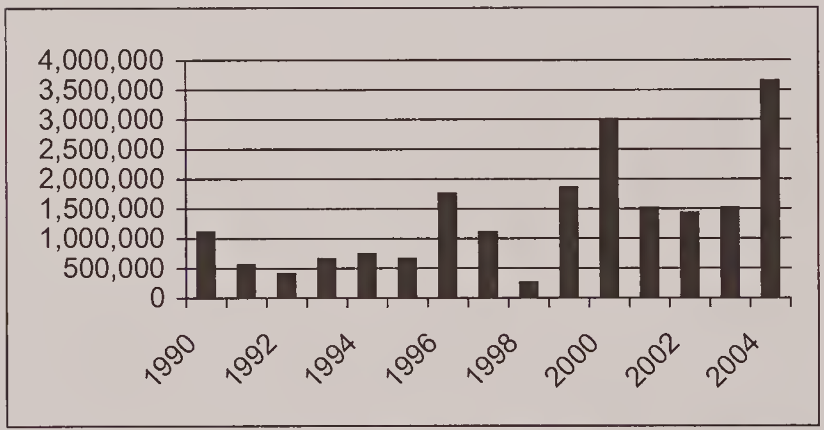


Figure 1-1. Acres of Public Land Burned Annually by Wildfires since 1990.

As a result, western U.S. forests are currently denser and dominated by late-seral, fire-intolerant species, and are experiencing unprecedented insect and disease outbreaks. The result is not only more frequent and more intense wildfires, but also more catastrophic effects from these fires. Today, wildfires often result in nearly complete mortality of all the trees regardless of tree size or species. The size of these fires are reaching unprecedented levels, often destroying fish and wildlife habitat, damaging water quality, and sterilizing soils that are vital to reestablishment of native forest conditions. Forests are also experiencing an invasion of exotic plant species in their understories that reduce their quality as wildlife habitat and provide fine material that promotes the rapid spread of wildfire.

Western U.S. grasslands and shrublands have experienced similar changes in vegetation as forestlands over the past century. Drought conditions and wildfires have burned millions of acres of grasslands and shrublands, and often non-native vegetation and noxious weeds have replaced native vegetation in burned areas (USDI BLM 2001a). Since annual grasses, in particular, cure quickly and carry fire faster, the areas they dominate become more prone to burn and the weed-fire-weed cycle is perpetuated. Monocultures of downy brome and other unwanted vegetation provide fewer habitat, water quality, and recreation benefits than areas with native vegetation. In other areas, fire control efforts have allowed less fire tolerant species, such as pinyon-juniper, to dominate in areas where fire once controlled their spread, often resulting in the loss of grassland and shrubland habitat.

The attention paid to wildland fire has changed dramatically over the last several years. A 1999 report from the U.S. Government Accounting Office (GAO) found that fuel build up was a major problem in the western U.S. and recommended that the Forest Service develop a cohesive strategy to restore and maintain ecosystem health in fire-adapted ecosystems in the western U.S. focusing on "short-interval" fire adapted ecosystems (GAO 1999, USDA Forest Service 2000).

One result of this strategy was the identification of fire regime and condition classes for federal lands in the continental U.S. The fire regime condition class (FRCC) concept is used to describe both the historic fire regime and the degree of departure. FRCC uses five fire regime groups to classify the historic fire frequency and severity for a given plant community. In addition, FRCC uses three broad condition classes to explain the degree of departure from the native fire regime. These condition classes range from 1 to 3, with the risk of loss of key ecosystem components from unwanted wildland fire increasing from Fire Regime Condition Class (FRCC) 1 (lowest risk) to FRCC Class 3 (highest risk).

Upon completion of the Forest Service cohesive strategy, the USDI (including the BLM) began work on an interdepartmental strategy to expand this framework seamlessly across the federal wildland fire management agencies. This effort identified actions that are included in the current BLM effort to reduce hazardous fuels and reintroduce fire into fire-adapted ecosystems.

Following the fire season of 2000, the Presidential Report entitled *Managing the Impacts of Wildfires on Communities and the Environment* (USDA and USDI 2000a), was completed in response to a request from the President to determine how best to respond to the severe fire season. Key recommendations from this report included:

- Providing additional firefighting resources;
- Restoring damaged landscapes and communities;
- Increasing investment to reduce fire risk with an emphasis on multi-jurisdictional efforts; and
- Working directly with local communities at risk to improve community fire fighting capacity and coordination, implementing fuel reduction projects, and expanding education and risk mitigation efforts in the WUI.

This report provided the basis and conceptual framework for the *National Fire Plan* (USDI and USDA 2001) and *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-Year Comprehensive Strategy Implementation Plan* (USDI and USDA 2006a).

The *National Fire Plan* is a long-term, multi-faceted strategy designed to manage the impact of wildland fire to communities and ecosystems and to reduce wildfire risk. In addition to the BLM, this plan encompasses the Forest Service and the other land management agencies within the USDI with wildland fire management responsibilities (National Park Service, USFWS, and the Bureau of Indian Affairs). The 10-Year Comprehensive Strategy Implementation Plan extended the concepts of the President's report and the *National Fire Plan* into a broader, collaborative effort involving the Western States Governors Association. Specific actions of this plan included:

- Improving fire prevention and suppression efforts;
- Reducing hazardous fuels;
- Restoring fire-adapted ecosystems; and
- Promoting community assistance.

In August of 2002, the President introduced the *Healthy Forests Initiative*. This initiative is designed to facilitate projects that reduce wildfire hazard and risk by making decisions in a more timely and efficient manner. The initiative has legislative and administrative components that were put into law by the *Healthy Forests Restoration Act of 2003*.

The BLM presently treats about 500,000 acres annually to reduce wildfire risks from hazardous fuels. To respond to the goals of the *National Fire Plan*, the BLM proposes to increase hazardous fuels reduction (HFR) work by approximately 3 million acres annually (to 3.5 million acres annually) to reduce the risk of wildfire to life and property. This work would require use of fire and non-fire vegetation treatment methods to reduce the risk of catastrophic wildfire and to reintroduce fire as an essential ecosystem component and process. This HFR work would be focused on lands with "abnormal" fire cycle conditions characterized by high intensity fire events with loss of resources and resource damage, including life and property.

In response to catastrophic and resource damaging wildfire, the BLM restores approximately 1.5 million acres of wildfire-damaged lands annually under its Burned Area Emergency Stabilization and Rehabilitation program. Activities conducted under this program include the stabilization of soils and reseeding of fire-damaged areas, in addition to the use of herbicides to prevent the establishment of invasive species, such as downy brome, in those areas where there may be a risk of post-fire invasion of weeds and other invasive species.

In addition to the work identified to reduce hazardous fuels and conduct post-fire stabilization and rehabilitation, approximately 1 million acres of vegetation treatments are conducted annually through other BLM resource programs. These programs are discussed in Chapter 2 and are responsible for controlling weeds and invasive species; modifying forest composition and structure to lessen insect and disease mortality; improving fish and wildlife habitat, including that of threatened and endangered species; improving riparian and wetland areas; and improving water quality in priority watersheds.

The BLM faces many challenges in managing for healthy lands. The Federal Land Policy and Management Act (FLPMA) requires that public lands under the BLM's jurisdiction be managed for a variety of uses, including recreation, grazing, timber harvesting, and energy and mineral development, while ensuring that important environmental, historic, cultural, and scenic values are protected. These uses do cause impacts to the land which can lead to declines in the overall health of the land. As a result, the BLM strives

to attain a balance between the use of the land under its jurisdiction, and the protection of the environmental, historic, cultural, and scenic values that are so important to the American public. To ensure this protection of values, the FLPMA further directs the BLM, through authority granted the Secretary of the Interior, to take any action necessary to prevent unnecessary or undue degradation of lands.

Recognizing that human use can impact public lands, the BLM is committed to the multiple use mandates identified in FLPMA. The ability of BLM land managers to limit the threats and risks to healthy landscapes, to use vegetation treatment and other management techniques to restore degraded lands, and to maintain lands that are healthy, will determine the success of the BLM in meeting its land management responsibility. Because healthy lands are more resilient to environmental fluctuation and disturbance than degraded lands, they are better able to sustain consumptive uses such as livestock grazing, woodland products harvesting, hunting and fishing, and other recreational activities on a long-term basis. In this regard, vegetation treatment is a critical component of restoring and maintaining the health of the land, which in turn, is critical to providing long-term sustainability of resource outputs, as mandated by FLPMA.

Scope of Report

This PER discusses the effects of treating vegetation on approximately 6 million acres of public lands annually in the western U.S. and Alaska. These lands include areas of critical environmental concern, Oregon and California Land Grant lands, Coos Bay Wagon Road lands, and lands administered by the BLM through its National Landscape Conservation System, such as wilderness study areas, designated Wilderness, National Monuments, National Recreation Areas, and National Conservation Areas.

The focus of this PER is to provide the methods, techniques, and tools of vegetation treatment to reduce hazardous fuels, improve rangeland health, and manage and control vegetation affecting other resources. This PER will not, however, discuss vegetation treatment activities that are not directly related to the need to reduce hazardous fuels, or to control vegetation to improve rangeland and forestland health. Thus, this PER will not consider vegetation management that is focused primarily on commercial timber or other forest product enhancement or use activities that are not related to improving forest health, HFR, or work authorized under the *Healthy Forests Restoration Act of 2003*. .

This PER will not include policies and programs associated with land use activities authorized by the BLM, such as livestock use, off-highway vehicle (OHV) use, and timber harvesting, and will not make land use allocations nor amend approved land use plans (Federal Register 2002). Human-related activities and natural processes have inherent risks and threats to the health of the land, which can lead to the decline of plant communities and ecosystems. Although this PER refers to activities consistent with the authorities under FLPMA and other statutes that may contribute, in some cases, to land and resource degradation (e.g., livestock grazing, OHV use, recreation), its focus is on proactive vegetation treatments to maintain and restore ecological conditions.

Commercial timber activities conducted with the primary purpose of providing a sustained-yield of timber volume to commercial industries are not included in this PER. Rather they are a form of vegetation harvest, as the species (product) is removed and replanted for future harvest. Commercial timber allocations and sustainable harvest have been previously analyzed in BLM resource management plan EISs for the field offices with timber programs.

Although this PER addresses vegetation treatments, it will not directly address any other aspects of the livestock grazing program, including forage production or the effects of livestock grazing on vegetation. The effects on vegetation that result from livestock forage use on public lands have been analyzed in previous EISs, at the national level (USDI BLM 1994) and at the local land use planning level, in either resource management plan EISs or as individual EISs or environmental assessments (EAs) at the field office level as well as at the allotment-specific level.

This PER will not address abandoned mine land reclamation, or energy production. Abandoned mine land reclamation is a form of site stabilization and remediation that does not necessarily involve vegetation treatment activities, although in some cases vegetation treatments may be associated with site stabilization. The scope of analysis for the overall use of herbicides and other methods of control would sufficiently cover their use in these types of activities.

This PER will not address fire suppression operations, as they do not constitute vegetation treatment actions. This PER will address soil stabilization only where

specifically related to the vegetation treatment activities. Soil stabilization effects are related to post-fire emergency stabilization (activities undertaken within 1 year of the fire control date) and rehabilitation (treatments applied up to 3 years after the fire control date).

Determination of Treatment Acreages

As discussed earlier, the BLM has been mandated under a variety of statutes and policy initiatives to increase the number of acres of vegetation treated annually to address the issues of catastrophic fire and invasive species spread and their relationships to habitat improvement and maintenance of healthy landscapes. The BLM estimates that approximately 6 million acres would need to be treated annually to meet these mandates. Acres to be treated by the BLM and assessed in this PER were estimated based on information provided by BLM field offices throughout the western U.S., including Alaska. Each field office was asked to estimate and summarize proposed vegetation treatment projects likely to occur during the next 10 years. For each project, the field office provided an estimate of the number of acres proposed for treatment, the general vegetation type(s) proposed for treatment, and the vegetation treatment method(s) proposed to be used. In many cases, multiple treatment methods were identified for a particular type of project. Treatments could occur on the same acres several times during 1 year, or over several years. Based on these surveys, field offices identified approximately 4.6 million acres of treatments would be needed annually.

The BLM also reviewed FRCCs and concluded that an additional 1.4 million acres of treatments beyond the estimates provided by the field offices for work likely to occur over the next 10 years would be required annually. This work would be focused on those areas of vegetation exhibiting FRCC 3 characteristics in the effort to meet national goals of transitioning FRCC 3 areas towards FRCCs 2 and 1.

As a result of these surveys and reviews, an estimated 6 million acres would need to be treated annually. Approximately 3.5 million acres would be treated primarily for HFR and to control wildfires in the WUI, approximately 1 million acres would be treated to control unwanted vegetation to restore ecosystem health, and about 1.5 million acres a year would be subject to Burned Area Emergency Stabilization and Rehabilitation efforts. Acres associated with Burned Area Emergency Stabilization and Rehabilitation treatments are dependent on the severity and extent of the fire season in any given year and may vary considerably from this average.

Documents that Influence the Scope of the PER

Much of the scope of this PER is based on several EISs that were prepared from 1985 through 1992 to evaluate the use of herbicides for vegetation treatment activities on public lands. These EISs include the *Northwest Area Noxious Weed Control Program EIS* (USDI BLM 1985), *Supplement to the Northwest Area Noxious Weed Control Program* (USDI BLM 1987b), *California Vegetation Management Final EIS* (USDI BLM 1988a), *Final EIS Vegetation Treatment on BLM Lands in Thirteen Western States* (USDI BLM 1991a), and *Final Record of Decision Western Oregon Program-Management of Competing Vegetation* (USDI BLM 1992a).

These documents identify vegetation treatment activities involving the use of herbicides in 14 western states and evaluate the risks of using 22 herbicide active ingredients. Where appropriate, information in these documents that is relevant to the assessment of BLM vegetation treatment practices is cited and incorporated by reference.

Other documents and policies that influence the scope of this PER include: 1) *National Fire Plan* (USDI and USDA 2001); 2) *Healthy Forests Restoration Initiative of 2002 and Healthy Forests Restoration Act of 2003* (Public Law 108-148); 3) Chapter 3 *(Interagency Burned Area Emergency Stabilization and Rehabilitation)* in BLM Manual 620 (*Wildland Fire Management*; USDI 2004); 4) *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-Year Comprehensive Strategy Implementation Plan* (USDI and USDA 2006a); 5) *Protecting People and Sustaining Resources in Fire Adapted Ecosystems: A Cohesive Strategy* (USDA and USDI 2006b); 6) *Draft Interagency Burned Area Emergency Response Guidebook* (USDA and USDI 2006c); 7) *Interagency Burned Area Rehabilitation Guidebook* (USDA and USDI 2006d); and 8) *Draft Burned Area Emergency Stabilization and Rehabilitation Handbook* (H-1742-1; USDI BLM 2006a). These documents provide policy and guidance for hazardous fuels reduction and land restoration activities to reduce the risk of wildfires and restore fire-adapted ecosystems, and to rehabilitate and

restore lands damaged by wildfires. The BLM's *Partners Against Weeds: An Action Plan for the Bureau of Land Management* (USDI BLM 1996) and *Pulling Together: National Strategy for Invasive Plant Management* (USDI BLM 1998a) are national level strategies for invasive species prevention and management.

Numerous other BLM manuals and handbooks were also consulted when developing the PER. These are listed in Appendix B.

Relationship to Statutes, Regulations, and Policies

Federal Laws, Regulations, and Policies that Influence Vegetation Treatments

Several federal laws, regulations, and policies guide BLM management activities on public lands. The ***Federal Land Policy and Management Act of 1976 (FLPMA)*** directs the BLM to manage public lands "in a manner that will protect the quality of scientific, scenic, historic, ecological, environmental, air and atmospheric, water resources and archeological values" and to develop resource management plans (RMPs) consistent with those of state and local governments to the extent that BLM programs also comply with federal laws and regulations. The ***Taylor Grazing Act of 1934*** introduced federal protection and management of public lands by regulating grazing on public lands. The ***Oregon and California Grant Lands Act of 1937*** provides for the management of the revested Oregon and California and reconveyed Coos Bay Wagon Road grant lands for permanent forest production under the principle of sustained yield and for leasing of lands for grazing.

Several acts provide for management and control of invasive vegetation. Two weed control acts, the ***Carlson-Foley Act of 1968*** and the ***Plant Protection Act of 2000*** (Public Law 106-224; includes management of undesirable plants on federal lands) authorize the BLM to manage noxious weeds and to coordinate with other federal and state agencies in activities to eradicate, suppress, control, prevent, or retard the spread of any noxious weeds on federal lands. The ***Federal Noxious Weed Act of 1974*** established and funded an undesirable plant management program, implemented cooperative agreements with state agencies, and established integrated management systems to control undesirable plant species. The ***Noxious Weed Control Act of 2004*** established a program to provide assistance through states to eligible weed management entities to control or eradicate harmful, nonnative weeds on public and private lands. The ***Public Rangelands Improvement Act of 1978*** requires the BLM to manage, maintain, and improve the condition of the public rangelands so that they become as productive as feasible.

The BLM must comply with numerous federal laws that govern activities on public lands. ***The Clean Air Act***, as revised in 1990, would primarily govern prescribed fire smoke emissions, and requires the USEPA and states to carry out programs to assure attainment of the National Ambient Air Quality Standards (NAAQS). The ***Safe Drinking Water Act*** is designed to protect the quality of public drinking water and its sources. The ***Wilderness Act of 1974*** provides management directions to protect wilderness values and guides activities and permitted uses within these areas.

The Clean Water Act regulates discharges into waters of the United States, including wetlands. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Based on a recent ruling by the USEPA (2006), an NPDES permit is not required for applications of herbicides directly to water in order to control aquatic vegetation, or for application of herbicides that are present over or near water, where a portion of the herbicide will unavoidably be deposited to the water in order to target the pest vegetation. The ruling does not apply to terrestrial herbicide applications that drift over and into waters of the U.S.; issues related to these applications are under review by the USEPA.

The USEPA regulates pesticides under two major federal statutes. The ***Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)*** establishes procedures for the registration, classification, and regulation of all pesticides. Before any pesticide may be sold legally, the USEPA must register it. The USEPA may classify a pesticide for general use if it determines that the pesticide is not likely to cause unreasonable adverse effects to applicators or the environment, or for restricted use if the pesticide must be applied by a certified applicator and in accordance with other restrictions. All the herbicides evaluated in the PEIS, except diflufenzopyr as a stand-alone active ingredient, are registered with the USEPA. Diflufenzopyr is approved as a formulation with dicamba and is labeled

as Distinct, but could not be used alone by the BLM until it is registered with the USEPA. All applicators that apply them on public lands (i.e., certified applicators or those directly supervised by a certified applicator) must comply with the application rates, uses, and handling instructions on the herbicide label, and where more restrictive, the rates, uses, and handling instructions developed by the BLM. Under the ***Federal Food, Drug, and Cosmetic Act***, the USEPA establishes tolerances (maximum legally permissible levels) for pesticide residues in food.

The ***Food Quality Protection Act of 1996*** changed the way the USEPA sets residue limits (tolerances) for pesticides on foods under the Federal Food, Drug, and Cosmetic Act, and the way the USEPA reviews and approves pesticides under FIFRA. Specifically, the Act mandated a single, health-based standard for all pesticides in all foods; provided special protections for infants and children; expedited approval of safer pesticides; created incentives for the development and maintenance of effective crop protection tools for American farmers; and required periodic reevaluation of pesticide registrations and tolerances to ensure that the scientific data supporting pesticide registrations will remain up to date in the future.

The ***Resource Conservation and Recovery Act (RCRA)*** regulates the disposal of toxic wastes, including the disposal of unused herbicides, and provides authority for toxic waste cleanup actions when there is a known operator. ***The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)*** regulates how to clean up spills of hazardous materials and when to notify agencies in case of spills.

Several laws pertain to the protection of plants and animals and their habitats. The ***Migratory Bird Conservation Act of 1929, as amended,*** makes it unlawful to directly, or indirectly, harm migratory birds. If the USFWS determines that migratory birds could be harmed by BLM vegetation treatment actions, the two agencies would develop a site-specific assessment and mitigation to prevent harm to these birds. ***The Endangered Species Act (ESA) of 1973*** provides for conserving endangered and threatened species of plants and animals. The ESA also requires that federal agencies consult with the USFWS and NMFS to ensure that any actions that they authorize, fund, or carry out are not likely to jeopardize the continued survival of a listed species or result in the adverse modification or destruction of its critical habitat. The ***Wild Free-Roaming Horse and Burro Act of 1971, as amended by the Public Rangelands Improvement Act of 1978*** provides for the management, protection, and control of wild horses and burros on public lands and authorizes the "adoption" of wild horses and burros by private individuals. The ***Fish and Wildlife Conservation Act of 1980*** encourages federal agencies to conserve and promote the conservation of non-game fish and wildlife species and their habitats. The ***Sikes Act of 1974*** authorizes the USDI to plan, develop, maintain, and coordinate programs with state agencies for the conservation and rehabilitation of wildlife, fish, and game on public lands.

Laws and acts that pertain to the protection of historic and cultural resources and the rights of Native American tribes and Alaska Native groups include the ***Historic Sites Act of 1935***, which provides for the preservation of historic American sites, buildings, objects, and antiquities of national significance. The ***National Historic Preservation Act (NHPA) of 1966*** requires federal agencies to take into account the potential affects of their actions on properties that are listed or are eligible for listing on the National Register of Historic Places (NRHP), and to consult with State Historic Preservation Officers (SHPOs), Indian tribes, and local governments regarding the effects of federal actions on historic properties. The ***Archeological Resources Protection Act of 1979*** prohibits the excavation, removal, damage, or other alteration or defacement of archaeological resources on federal or Indian lands without a permit. ***The American Indian Religious Freedom Act of 1978*** requires federal land managers to include consultation with traditional Native American or Alaska Native religious leaders in their management plans. The ***Native American Graves Protection and Repatriation Act of 1990*** recognizes the property rights of Native Americans and Alaska Natives in certain cultural items, including Native American and Alaska Native human remains and sacred objects. ***Section 810 of the Alaska National Interest Lands Conservation Act*** **(ANILCA)** addresses the effects of proposed activities on Alaska Native subsistence uses.

This PER follows the guidelines in several Executive orders (EOs). ***Executive Order 11990, Protection of Wetlands***, ensures that federal agencies minimize the destruction, loss, or degradation of wetlands, and enhance and preserve the natural and beneficial values of wetlands, when carrying out actions on federal lands. ***Executive Order 12898, Environmental Justice***, requires that federal agencies address the environmental justice of their actions on minority populations and on low-income populations. ***Executive Order 13045, Protection of Children from Environmental Health***

Risks and Safety Risks, ensures that federal agencies identify and assess the environmental health and safety risks that may disproportionately affect children. ***Executive Order 13084, Consultation and Coordination with Indian Tribal Governments*** directs federal agencies to respect tribal self-government and sovereignty, tribal rights, and tribal responsibilities whenever they formulate policies "significantly or uniquely affect Indian tribal governments." ***Executive Order 13112, Invasive Species,*** directs federal agencies to prevent the introduction of invasive species and provide for their control, and to minimize the economic, ecological, and human health impacts that invasive species cause. ***Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds***, requires that federal agencies that have, or are likely to have, a measurable negative effect on migratory bird populations develop a Memorandum of Understanding (MOU) with the USFWS that shall promote the conservation of migratory bird populations.

Relationships among Land Use, Land Use Planning, Land Health Standards, Ecosystem Functionality, and Vegetation Treatments

Land uses authorized by the BLM, such as livestock grazing, OHV use, timber harvest, and energy development, are guided by local land use plans such as RMPs, and Management Framework Plans (MFPs). Collectively, land use plans outline the specific resource goals and objectives and use allocations for a specific geographic area. The uses and allocations allowed by the land use plan are analyzed in the EIS associated with the development of the land use plan. Land use plans are developed to include the proposed action and alternatives that identify specific management strategies to meet particular national, regional, and local goals and objectives.

In addition to setting goals, objectives, and use allocations, land health standards and associated guidelines on how to meet standards are incorporated at the land use plan level (Figure 1-2). Land health standards are expressed as goals, common to all alternatives in the land use plan, and are applied regardless of the alternative selected.

In order to meet certain land use plan objectives, vegetation treatments are often used to reach desired states of vegetation or mixes of vegetation. For example, mechanical thinning and prescribed fire may be used to convert a monoculture of juniper with little understory to a more open savanna and mosaic vegetation pattern with a healthy understory of forbs and grasses to improve wildlife habitat.

It is important to understand that the land use plan will not necessarily address *how* the objective will be met. How the objective will be met is determined at the land use plan implementation level (project level) through further study and analysis. Temporary curtailment of uses authorized in a land use plan is within the authority and discretion of the authorized officer. However, permanent curtailment of uses requires a land use plan amendment.

Interrelationships and Coordination with Agencies

In its role as manager of nearly 261 million acres in the western U.S., including Alaska, the BLM has developed numerous relationships at the federal, tribal, state, and local levels, as well as with conservation and environmental groups with an interest in resource management, and members of the public that use public lands or are affected by activities on public lands.

As noted previously, several federal agencies administer laws that govern activities on public lands. Federal agencies, including the Department of Defense, the Department of Energy, the National Park Service, the USFWS, the Bureau of Reclamation, the Bureau of Indian Affairs, and the USDA Forest Service, administer lands adjacent to or in close proximity to public lands administered by the BLM, and have vegetation management issues that are similar to the BLM's. Other agencies, such as the Agricultural Research Service, the Animal, Plant, Health Inspection Service, the Natural Resource Conservation Service, and the U.S. Geological Survey Biological Services, play vital roles in coordination with national, tribal, state, county and private interests through their oversight and coordination responsibilities. These agencies and the BLM regularly coordinate on vegetation management and control efforts to benefit all federally-administered lands. Other local coordination includes the sharing of equipment, training, and financial resources, and developing vegetation management plans that cross administrative boundaries.

National Level Coordination

Invasive species management is coordinated by several groups at the national level. The National Invasive

Species Council was formed among several federal agencies per Executive Order 13112 to develop strategies to control invasive species on federal lands. Comprised of 16 federal agencies with direct invasive plant management responsibilities, the Federal Interagency Committee for the Management of Noxious and Exotic Weeds serves to coordinate invasive plant management activities in federal lands across the United States and its territories. A related committee is the Federal Interagency Committee on Invasive Terrestrial Animals and Pathogens, which consists of ten federal departments and agencies responsible for managing non-vegetative invasive species in terrestrial ecosystems. The BLM also coordinates with the Aquatic Nuisance Species Task Force, which is co-chaired by the USFWS and NMFS, and is responsible for coordinating efforts by the federal government and the private sector in controlling aquatic nuisance species. The BLM also produces national level strategies for invasive species prevention and management (e.g., *Partners Against Weeds: An Action Plan for the Bureau of Land Management* [USDI BLM 1996], and *Pulling Together: National Strategy for Invasive Plant Management* [USDI BLM 1998a]).

Fire and fuels management coordination involves both federal and state entities. The Wildland Fire Leadership Council is a cooperative, interagency organization dedicated to achieving consistent implementation of the goals, actions, and policies in the *National Fire Plan* and the *Federal Wildland Fire Management Policy*. The National Fire and Aviation Executive Board was established to resolve wildland fire management issues on an interagency level by improving coordination and integration of federal fire and aviation programs.

The National Interagency Fuels Coordination Group, chartered under the National Fire and Aviation Executive Board, was established shortly after the *National Fire Plan* in October of 2001 under the direction and guidance of the Department of the Interior's Bureau of Indian Affairs, BLM, USFWS, National Park Service, and USDA Forest Service. The primary purpose of the group is to provide leadership and coordination in uniting the Departments' resources and fire management programs under a common purpose for reducing risks to communities while improving and maintaining ecosystem health. The Group provides assistance and guidance in the development and implementation of an effective interagency fuels management program, which includes addressing risks from severe fires in WUI communities and restoring healthy ecological systems in other wildland areas.

The National Wildfire Coordinating Group provides coordination among the following agencies and their programs: USDA Forest Service; USDI BLM, National Park Service, Bureau of Indian Affairs, and USFWS; and the National Association of State Foresters. The BLM is also one of six federal agencies that provide scientific support for the management of fuels and wildland fires in the Joint Fire Science Program.

State and County Level Coordination

The BLM is required to coordinate with state and local agencies under several acts, including: the Clean Air Act, the Sikes Act, FLPMA, and Section 106 of the NHPA. The BLM coordinates closely with state resource management agencies on issues involving the management of public lands, the protection of fish and wildlife populations, including federal- and state-listed threatened and endangered species, invasive and noxious weeds, fuels and wildland fire management, and herbicide application. Herbicide applications are also coordinated with state and local water quality agencies to ensure treatment applications are in compliance with applicable water quality standards, and do not result in unacceptable surface or ground water contamination.

Local and state agencies work closely with the BLM to manage weeds on local, state, and federal lands, and are often responsible for weed treatments on public lands. The BLM participates in exotic plant pest councils, state vegetation and noxious weed management committees, state invasive species councils, county weed districts and weed management associations found throughout the West.

The Healthy Forests Restoration Act (HFRA) directs the USDA Forest Service and USDI BLM to develop an annual program of work for federal land that gives priority to authorized hazardous fuel reduction projects that provide for protecting at risk communities or watersheds. The recommendations made by Community Wildfire Protection Plans (described under Coordination in Chapter 2) are taken into account by the agencies in accordance with HFRA, which gives priority in allocating funding to communities that have adopted these plans, or that have taken measures to encourage willing property owners to reduce fire risk on private property (USDA Forest Service and USDI BLM 2004). All prescribed burning is coordinated with state and

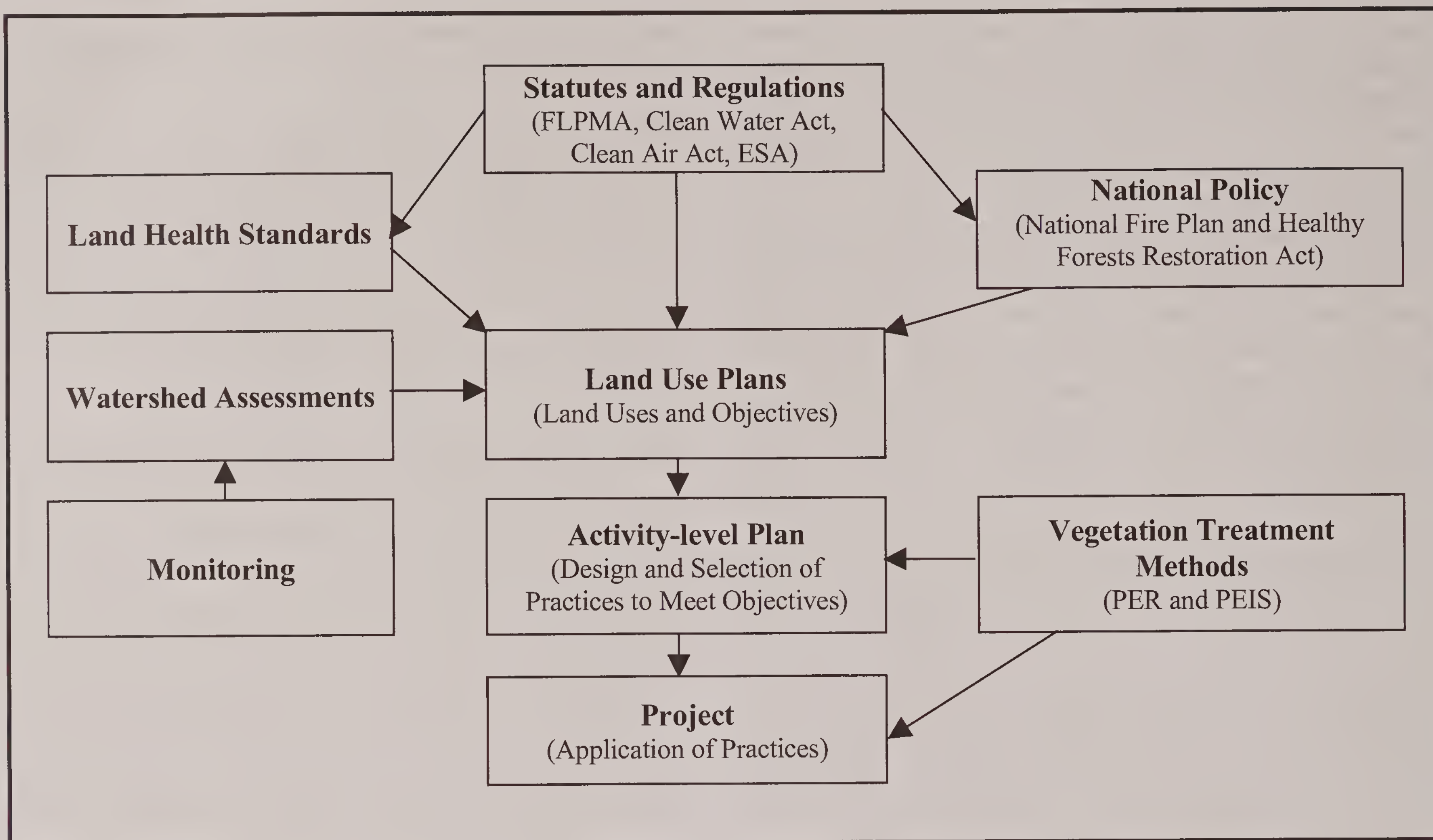


Figure 1-2. Relationships among Land Use Planning Activities and Vegetation Treatments PER and PEIS.

local air quality agencies to ensure that local air quality is not significantly impacted by BLM activities.

Non-governmental Organizations

The BLM coordinates at the national and local levels with several resource advisory groups and non-governmental organizations, including: BLM Resource Advisory Councils, the Western Governors' Association, the National Association of Counties, the Western Area Power Administration, the National Cattlemen's Association, the National Wool Growers Association, the Society of American Foresters, and the American Forest and Paper Association. The BLM also solicits input from national and local conservation and environmental groups with an interest in land management activities on public lands, such as The Nature Conservancy. These groups provide information on strategies for weed prevention, effective weed treatment methods, use of domestic animals to control weeds, landscape level planning, vegetation monitoring, techniques to restore land health, and methods to ensure that prescribed burning does not impact the safe operation of power transmission lines.

Cooperative Weed Management Areas

Cooperative Weed Management Areas (CWMAs) are composed of local, private, and federal interests. CWMAs typically center on a particular watershed or similar geographic area in order to pool resources and management strategies in the prevention and control of weed populations. Much of the BLM's on-the-ground invasive species prevention and management is done directly or indirectly through CWMAs. The BLM participates in numerous CWMAs throughout the west, several of which are showcase examples of interagency and private cooperation in restoring land health.

Consultation

As part of the PEIS, the BLM consulted with the USFWS and NMFS as required under Section 7 of the ESA (see Appendix C). The BLM prepared a formal initiation package that included: 1) a description of the program, listed threatened and endangered species, species proposed for listing, and critical habitats that may be affected by the program; and 2) a *Biological Assessment for Vegetation Treatments on Bureau of Land Management Lands in 17 Western States* (BA).

The BA evaluated the likely impacts to listed species, species proposed for listing, and critical habitats from the proposed use of herbicides and other treatment methods in its vegetation treatment program and identified management practices to minimize impacts to these species and habitats.

The BLM initiated consultation with Native American tribes and Alaska Native groups to identify their cultural values, religious beliefs, traditional practices, and legal rights that could be affected by BLM actions. This included sending out letters to all tribes and groups that could be directly affected by vegetation treatment activities, and requesting information on how the proposed activities could impact Native American and Alaska Native interests, including the use of vegetation and wildlife for subsistence, religious, and ceremonial purposes (see Appendix C).

The BLM conducted an ANILCA § 810 Analysis of Subsistence. During this process, the BLM invited public participation and collaborated with Alaska Natives to identify and protect culturally significant plants used for food, baskets, fiber, medicine, and ceremonial purposes. The findings required by ANILCA § 810 are given in Appendix H of the PEIS.

The BLM also consulted with SHPOs as part of Section 106 consultation under the NHPA to determine how proposed vegetation treatment actions could impact cultural resources. Formal consultations with SHPOs and Indian tribes also may be required during implementation of projects at the local level (see Appendix C).

Preview of Remainder of PER

Because this PER contains a broad range of information, Figure 1-3 shows the types of information found in the PER, and where it is located.

VOLUME 1

Chapter 1 Purpose of the Environmental Report
Summarizes the purpose and scope of analysis for the PER.

Chapter 2 Vegetation Treatment Programs, Policies, and Methods
Describes the BLM vegetation treatment programs, policies, and treatment methods.

Chapter 3 Public Land Resources
Presents existing natural and socioeconomic resources on public lands in the western U.S.

Chapter 4 Effects of Vegetation Treatments
Evaluates the effects of the vegetation treatments on public land resources in the western U.S. and describes standard operating procedures to minimize impacts to resources.

Chapter 5 References
Lists the documents and other sources used to prepare the PER.

Chapter 6 Glossary
Provides definitions for important terms used in the PER.

Chapter 7 Index
Lists where significant issues, resource descriptions, terms, and agencies and groups discussed in the PER are located.

Appendixes

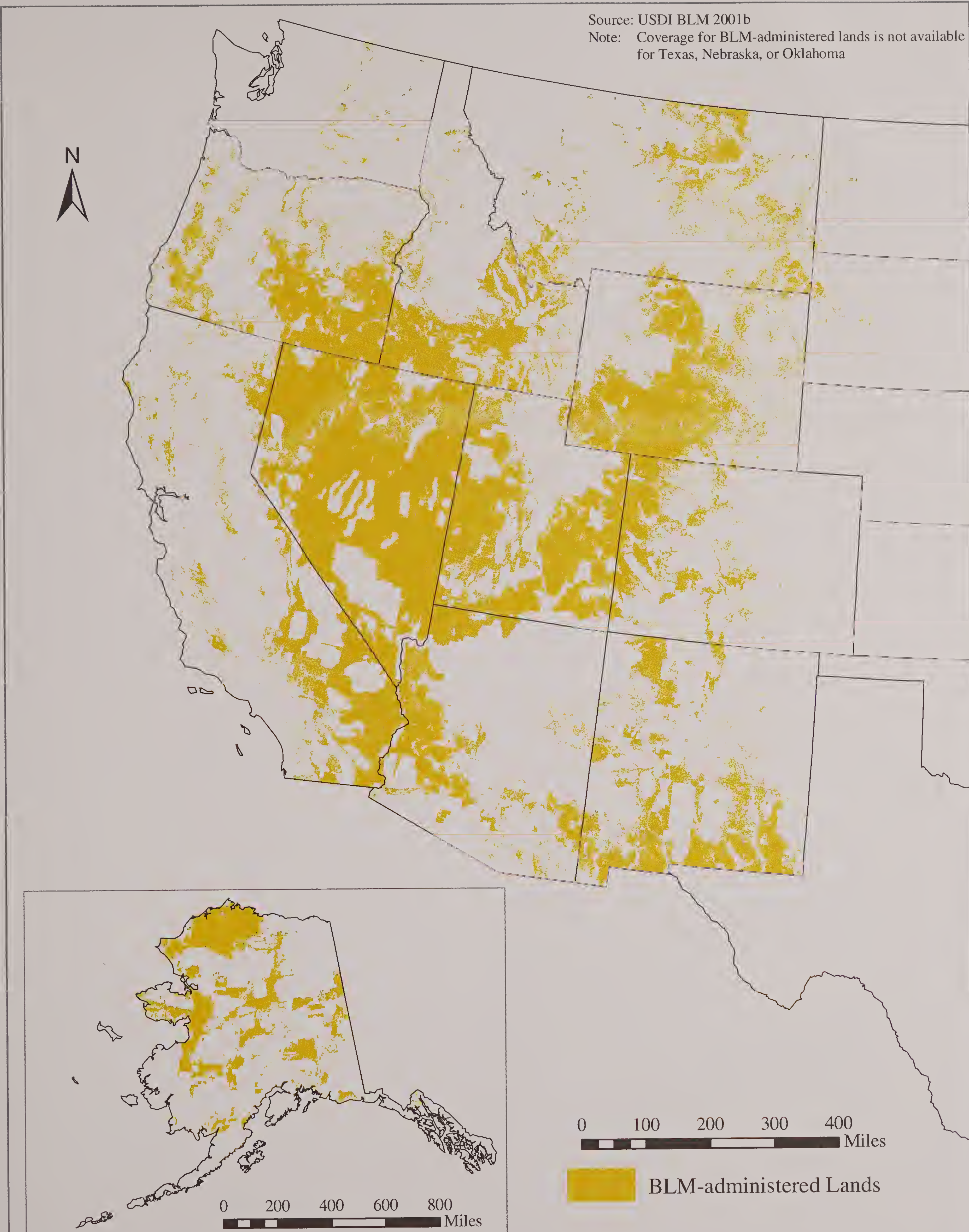
A. Common and Scientific Names of Plants and Animals Given in the PER
B. BLM Reference Manuals and Handbooks Referred to in the PER
C. Consultation Agreements
D. Native American Resource Use
E. Cultural Resources
F. Special Status Species List

Acronyms, Abbreviations, and Symbols (fold-out at end of PER)
Lists the acronyms, abbreviations, and symbols used in the PER.

Related Reports
(on the CD located in the back pocket of PEIS Volume I)

1. Air Quality Modeling for BLM Vegetation Treatment Methods
2. Annual Emissions Inventory for BLM Vegetation Treatment Methods
3. Air Quality Policies Summary for the Vegetation Treatments PEIS and PER
4. Paleontological Overview for the Western United States

Figure 1-3
Organization of the Programmatic ER



Map 1-1
Public Lands Administered by the Bureau of Land Management

CHAPTER 2

VEGETATION TREATMENT PROGRAMS, POLICIES, AND METHODS

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CHAPTER 2

VEGETATION TREATMENT PROGRAMS, POLICIES, AND METHODS

The BLM programs and policies provide broad guidance for determining and prioritizing appropriate site-specific vegetation treatment methods. This chapter discusses these programs, policies, and initiatives, and concludes with a discussion of vegetation treatment methods and standard operating procedures (SOPs) used to reduce impacts to the environment from treatment activities.

Programs, Policies, and Initiatives Influencing Vegetation Treatment Activities

Program Goals

In order to be effective, vegetation management by the BLM must involve all programs that rely on healthy plant species and communities to meet their objectives. The BLM's overarching goal for vegetation management is as follows:

> *Through an interdisciplinary collaborative process, plan and implement a set of actions that improve biological diversity and ecosystem function and which promote and maintain native plant communities that are resilient to disturbance and invasive species. Healthy functioning plant communities will enhance the ability to attain economic benefits on public land* (USDI BLM 2006b).

If this goal is met, eventually the number of acres needing treatment should be reduced as a result of overall improvement in conditions. To achieve this goal, the BLM must 1) understand and plan for the condition and use of public lands, 2) focus on restoring sites that will most benefit from treatments, 3) select the appropriate treatments and SOPs to improve the likelihood of restoration success, 4) monitor treatments to better understand what treatments are successful or unsuccessful, and 5) convey information about treatment activities to BLM staff and the public.

Concurrently, public lands must be administered under the principles of multiple use and sustained yield in accordance with the intent of Congress as stated in the FLPMA. Thus, vegetation must be managed to protect and enhance the health of the land while providing a source of food, timber, and fiber for domestic needs (USDI BLM 2000c). Land-disturbing activities must be conducted in a manner that minimizes ecosystem fragmentation and degradation, and lands should be rehabilitated when necessary to safeguard the long-term diversity and integrity of the land.

Planning and Management at the National Level

Wildland Fire Management Program

As discussed in Chapter 1, the BLM is increasing the amount of land treated annually from nearly 2 million acres to about 6 million acres primarily in response to Presidential and Congressional mandates to reduce the risk of wildfire by reducing the occurrence of hazardous fuels, especially in the WUI, restoring fire-adapted ecosystems, and repairing lands damaged by fire. Public lands that are subject to these mandates total about 5 million acres annually. The remaining 1 million acres would be treated based on the needs of other programs within the BLM.

Efforts to reduce the risk of wildfire are primarily the responsibility of the Wildland Fire Management program. During fiscal year (FY) 2005, the Wildland Fire Management program conducted hazardous fuel treatments on about 542,000 acres in the WUI and nearly 727,000 acres in non-WUI areas. The program conducted emergency stabilization and burned area rehabilitation activities on nearly 880,000 acres. Together, the USDI and Forest Service conducted over 3 million acres of hazardous fuels treatments and treated nearly 2.4 million acres in the WUI during FY 2005 (USDI BLM 2006c, d). Between 2001 and 2006, federal

land management agencies invested more than 60% of fuels treatment dollars in the WUI, enabling collaborative treatment of some 8.5 million acres near communities (USDI BLM 2006c).

Prior to 1998, the BLM managed hazardous fuels on approximately 57,000 acres annually. Historically, approximately 70% of acres were managed to restore fire-adapted ecosystems, while the remaining 30% were managed to reduce wildfire risks to communities.

Under current direction, the acreage treated annually by the BLM to reduce wildland fire risk would increase significantly, to about 3.5 million acres in the western U.S., including Alaska, and most treatments would occur in the WUI. Although all treatment methods would be used, prescribed fire and mechanical treatments would account for most fuels reduction in the continental U.S., and wildland fires for resource use would account for most fuels reduction in Alaska.

The Wildland Fire Management program is guided by the policies expressed in the following national policy documents: 1) *National Fire Plan* (USDI and USDA 2001a); 2) *Healthy Forests Initiative of 2002 and Healthy Forests Restoration Act of 2003* (Public Law 108-148); 3) Chapter 3 *(Interagency Burned Area Emergency Stabilization and Rehabilitation)* in BLM Manual 620 (*Wildland Fire Management*; USDI BLM 2004b); 4) *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-Year Comprehensive Strategy Implementation Plan* (USDI and USDA 2006a); 5) *Protecting People and Sustaining Resources in Fire Adapted Ecosystems: A Cohesive Strategy* (USDI and USDA 2006b); 6) *Draft Interagency Burned Area Emergency Response Guidebook* (USDI and USDA 2006c); 7) *Interagency Burned Area Rehabilitation Guidebook* (USDI and USDA 2006d); and 8) *Draft Burned Area Emergency Stabilization and Rehabilitation Handbook* (H-1742-1; USDI BLM 2006a).

Wildland Urban Interface (WUI)

The WUI has generally been defined by the National Wildfire Coordinating Group (NWCG) as "the line, area or zone, where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuel." A more specific definition is provided in the *Healthy Forests Restoration Act of 2003*:

1. An area within or adjacent to an at-risk community that is identified in recommendations to the Secretary of the Interior or Agriculture in a community wildfire protection plan (CWPP); or

2. In the case of an area for which a CWPP is not in effect:

(a) an area extending ½ mile from the boundary of an at-risk community;

(b) an area within 1½ miles from the boundary of an at-risk community, including any land that has a sustained steep slope that creates the potential for wildfire behavior endangering the at-risk community; has a geographic feature that aids in creating an effective fire break such as a road or ridge top; or is in Fire Regime Condition Class 3, as documented by the Secretary of the Interior in the project-specific environmental analysis; and

(c) an area that is adjacent to an evacuation route for an at-risk community that the Secretary determines, in cooperation with the at-risk community, requires hazardous fuel reduction to provide safer evacuation from the at-risk community.

The variation in the WUI definition allows local issues to drive the definition, but does not allow for national mapping of WUI.

National Fire Plan

The *National Fire Plan* was developed in August 2000, following a landmark wildland fire season, with the intent of actively responding to severe wildland fires and their impacts to communities while ensuring sufficient firefighting capacity for the future. The *National Fire Plan* addresses five key points: firefighting, rehabilitation, hazardous fuels reduction, community assistance, and accountability (National Fire Plan 2005).

The *National Fire Plan* continues to provide invaluable technical, financial, and resource guidance and support for wildland fire management across the U.S. Together, the Forest Service and the USDI are working to successfully implement the key points outlined in the *National Fire Plan* by taking the following steps:

- Assuring that necessary firefighting resources and personnel are available to respond to wildland fires that threaten lives and property.

- Conducting emergency stabilization and rehabilitation activities on landscapes and communities affected by wildland fire.
- Reducing hazardous fuels (dry brush and trees that have accumulated and increase the amount of fuel available to burn, potentially resulting in unusually large fires) in the country's forests and rangelands.
- Providing assistance to communities that have been or may be threatened by wildland fire.
- Committing to the Wildland Fire Leadership Council (WFLC), an interagency team created to set and maintain high standards for wildland fire management on public lands.

Since development of the *National Fire Plan* in 2000, several additional strategies and initiatives have been developed that guide fire management on BLM and other federally-administered lands. These are discussed below.

10-Year Comprehensive Strategy Implementation Plan

A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-Year Comprehensive Strategy Implementation Plan (10-Year Comprehensive Strategy), updated in December 2006, emphasizes 1) information sharing and monitoring of accomplishments and forest conditions, 2) a long-term commitment to maintaining the essential resources for implementation, 3) a landscape-level vision for restoration of fire adapted ecosystems, 4) the importance of using fire as a management tool, and 5) continual improvement in collaboration consistent with the orginal 10-Year Comprehensive Strategy.

The primary objective of the plan is to promote a greater degree of collaboration among federal, state, and local authorities through the implementation of a collaborative framework. The framework is based on three tiers of collaboration (local, state/regional/tribal, and federal). At each level, activities will focus on planning; prioritizing action and implementation responsibilities; timely decision making, particularly for implementing projects and activities; tracking performance, monitoring, and assuring that activities are consistent with relevant science and new information; and communicating to the public the goals, tasks and outcomes of the 10-Year Comprehensive Strategy.

The plan includes four main goals: 1) improve fire prevention and suppression, 2) reduce hazardous fuels, 3) restore fire adapted ecosystems, and 4) provide community assistance. It also addresses methods to evaluate whether federal government is effectively using the money devoted to the plan to attain the desired results.

Cohesive Strategy

Protecting People and Sustaining Resources in Fire Adapted Ecosystems: A Cohesive Strategy (Cohesive Strategy; USDI and USDA 2006b) focuses on goals 2, 3, and 4 of the 10- Year Comprehensive Strategy (listed above).

The Cohesive Strategy aims to lessen the risks from catastrophic wildfires by reducing hazardous fuels build-up in forests and woodlands, and by reducing threats from flammable invasive species in rangelands, with an emphasis on protecting communities.

The Cohesive Strategy provides a strategic and realistic approach for reducing fuels on Federal lands by focusing on specific goals that address the multiple factors that influence fuels treatments.

The Cohesive Strategy points the way to picking which acres to treat and treatment methods to use, and does so in ways that address multiple concerns voiced by various segments of society.

Four principles guide the Cohesive Strategy:

1. Prioritization – Priority should be give to the WUI and to sites outside the WUI where vegetation is most likely to support catastrophic fire (see Fire Regime Condition Class section).
2. Coordination – Coordination should occur between all BLM vegetation management programs to maximize their combined benefits towards overall fuels management objectives.
3. Collaboration – Each year's program of work should increasingly reflect input from, and priorities of, local, tribal, and state interests.
4. Accountability – In 2003, the WFLC signed an agreement on fuels treatment priorities. The WFLC brings together federal, state, tribal and local government leaders to provide coordination for fire and fuels treatment programs. The WFLC using agreed upon effectiveness and efficiency measures, tracks progress in reducing hazardous fuels nationally.

Healthy Forests Restoration Initiative of 2002

This Presidential initiative was developed to better protect people and natural resources by lowering procedural and process hurdles that impede the reduction of hazardous fuels on public lands. Administrative actions included:

- Creation of categorical exclusions for certain fuel reduction projects usable by all federal land managing agencies;
- Streamlining the appeals process within the existing administrative appeals framework;
- Streamlining the EA documentation process, resulting in concise public documents;
- Better coordinating Endangered Species Act consultations including development of joint counterpart Section 7 consultation regulations.

Healthy Forests Restoration Act of 2003

President Bush signed *the Healthy Forests Restoration Act of 2003* (P.L. 108-148) in December 2003. The Act is a detailed piece of legislation that serves to aid in the implementation of the goals of the *National Fire Plan*, the 10-year Comprehensive Strategy Implementation Plan and the *Healthy Forests Initiative of 2002*. The Act helps states, tribes, rural communities and landowners restore healthy forest and rangeland conditions on state, tribal, and private lands (USDI and USDA 2006a).

On lands meeting specific criteria, it provides streamlined approaches to satisfy NEPA requirements for collaboratively selected fuels treatment projects. The provisions of *Healthy Forests Restoration Act of 2003* can be applied to as many as 20 million acres of land administered by the Forest Service and the BLM.

Regarding removal of hazardous fuels, Title I of the Act:

- Provides authority for expedited vegetation treatments on certain types of Forest Service- and BLM-administered lands that: 1) are at risk of wildland fire, 2) have experienced windthrow, blowdown, or ice-storm damage, 3) are currently experiencing disease or insect epidemics, or 4) are at imminent risk of such epidemics because of conditions on adjacent land.
- Provides expedited environmental analysis of Healthy Forests Restoration Act projects, namely by requiring that fewer alternatives be analyzed for authorized projects.
- Provides administrative review before decisions are issued on proposed Healthy Forests Restoration Act projects on Forest Service-administered lands.
- Contains requirements governing the maintenance and restoration of old-growth forest stands when the Forest Service and BLM carry out Healthy Forests Restoration Act projects in such stands.
- Requires Healthy Forests Restoration Act projects on Forest Service- and BLM-administered lands to maximize retention of larger trees in areas outside of old-growth stands, consistent with the objective of restoring fire-resilient stands and protecting at-risk communities and federal lands.
- Requires using at least 50% of the dollars allocated to Healthy Forests Restoration Act projects to protect areas adjacent to communities at risk for wildland fire.
- Requires performance to be monitored when agencies conduct hazardous fuel reduction projects, and encourages multiparty monitoring that includes communities and other diverse stakeholders (including interested citizens and tribes).
- Encourages courts to expedite judicial review of legal challenges to Healthy Forests Restoration Act projects.
- Directs that when courts consider a request for an injunction on a Healthy Forests Restoration Act-authorized project, they balance the short- and long-term environmental effects of undertaking the project against the effects of taking no action.
- Requires collaboration between federal agencies and local communities, particularly when community wildfire protection plans are prepared. A community wildfire protection plan (CWPP) is developed in the context of the collaborative agreements and guidance established by the Wildland Fire Leadership Council. This plan is agreed to by the local government, local fire department, and state agency responsible for forest management, in consultation with interested parties and the federal land management agencies that manage

in the vicinity of an at-risk community. The CWPP plans identify and set priorities for areas needing hazardous fuel reduction treatments, and recommend the types and methods of treatments on federal and non-federal lands that will protect one or more at-risk communities and their essential infrastructure.

Other titles in the Act also:

- Encourage biomass removal from public and private lands.
- Provide technical, educational, and financial assistance to improve water quality and address watershed issues on non-federal lands.
- Authorize large-scale silvicultural research.
- Authorize the acquisition of Healthy Forest Reserves on private land to promote recovery of threatened and endangered species, and improve biodiversity and carbon sequestration.
- Direct the establishment of monitoring and early warning systems for insect or disease outbreaks.

Emergency Stabilization and Burned Area Rehabilitation

The goals of Emergency Stabilization and Burned Area Rehabilitation are to mitigate the adverse effects of fire on the soil and vegetation in a cost-effective and expeditious manner and to minimize the possibility of wildland fire recurrence or invasion of weeds. The acreage of public lands stabilized and rehabilitated under this program annually has ranged from less than 100,000 acres to nearly 4 million acres since 1996.

Appropriate use of Emergency Stabilization and Burned Area Rehabilitation funds includes implementing practices to:

- Protect life, property, and soil, water (including water dependent resources), and/or vegetation resources.
- Prevent unacceptable on-site or off-site damage.
- Facilitate meeting land use plan objectives per FLPMA and other federal laws.
- Reduce the invasion and establishment of undesirable or invasive plant species.

The terms rehabilitation and restoration are often used synonymously. Rehabilitation is the repair of a wildland fire area utilizing native and/or non-native plant species to obtain a stable plant community that will protect the burned area from erosion and invasion of weeds. Restoration is defined as the process of returning ecosystems or habitats to their original structure and species composition.

Other BLM Programs Associated with Vegetation Treatment Activities

Wildland fire management provides the basis for proposed vegetation treatment activities on approximately 5 million acres annually. The remaining 1 million acres would be treated based on the specific needs of several programs within the BLM that are responsible for vegetation treatments or influence how and where vegetation treatments are carried out on public lands. Types of treatments conducted by these programs include weed removal, prevention of non-native invasive or noxious weeds, fish and wildlife habitat improvement, habitat improvement for threatened and endangered species, restoration of riparian habitats, reforestation for forest health restoration and habitat improvement, modification of vegetation composition and structure to improve land health, and protection and enhancement of vegetation in areas with cultural resources and administrative facilities.

Each program, as described below, has its own objectives for vegetation management. The BLM is currently developing guidance on an integrated approach to vegetation management. The basic premise is that renewable resource programs within the BLM should be working toward common goals and objectives that will maximize the effectiveness of BLM management actions, as well as improve overall program efficiency. An integrated, interdisciplinary approach in planning, implementing and monitoring management actions, based on common goals and objectives will be established at all levels of the BLM.

Soil, Water, and Air Management

The Soil, Water and Air Management program is responsible for water and air quality on public lands, and for restoring threatened watersheds. Activities include assessing the physical condition of watersheds, identifying priority watersheds, and restoring watersheds through partnerships with states. The program also oversees the Abandoned Mine Land Cleanup program, the Federal Salinity Control program,

and various other ecological and environmental inventories, assessments, and restoration projects (USDI BLM 2006c).

During FY 2005, the program completed over 5 million acres of watershed-based land health assessments to support Land Health Standards assessments, environmental reviews of expiring livestock permits, watershed restoration activities, wildland fire rehabilitation, and mine land reclamation (USDI BLM 2006c). The program also collected soil inventory data on nearly 645,000 acres, monitored approximately 6,460 surface water stations, and cleaned up 175 abandoned mines (USDI BLM 2006c).

Rangeland Management

Approximately 165 million acres of public lands are upland rangeland, of which approximately 160 million acres are open to livestock grazing (USDI BLM 2006c). The Rangeland Management program in Alaska is responsible for reindeer grazing on approximately 5 million acres in western Alaska. The Rangeland Management program is responsible for upland health management, assessment, and restoration; rangeland improvement planning and implementation; allotment planning and administration; and resource monitoring. Management of rangeland ecosystems is conducted on a landscape basis through land use plans.

Vegetation treatment activities conducted by this program are designed to promote compliance with the state and regional rangeland health standards, but specific benefits of these projects often include livestock forage improvement, wildlife habitat improvement, suppression of plants that are toxic to wildlife and livestock, removal of plants that compete with more desirable vegetation, improvement of watershed conditions on rangelands, and restoration of native plant communities.

Vegetation treatments on public lands also include activities to control invasive species such as noxious and invasive weeds. The BLM uses an integrated pest management approach, more specifically integrated vegetation management. The goal of integrated vegetation management is to control invasive and unwanted vegetation, to prevent the spread of noxious weeds, to eradicate early-detected noxious weed species in areas where certain weeds have not been introduced or established, and to control weeds where they have become established. Vegetation control methods include physical and biological controls, and use of herbicides. The policy, direction, and requirements for planning and implementing integrated weed management are given in BLM Manual 9015, *Integrated Weed Management* (USDI BLM 1992b).

A total of 205,256 acres were treated to prevent the spread of noxious weeds and invasive plants in FY 2005, and an estimated 317,959 acres were treated in FY 2004 by the Invasive and Noxious Weed program (USDI BLM 2006d). In addition, nearly 4.2 million acres were inventoried for weeds during FY 2005.

Currently, the funding and labor resources available to combat weeds dictate a containment strategy. Actions will continue to be targeted at preventing the spread of weeds into the most vulnerable areas (USDI BLM 2000b).

Public Domain Forest Management

Approximately 26 percent (69 million acres) of the lands managed by BLM consist of forestlands and woodlands (USDI BLM 2006e). Of these lands, 58 million acres are classified as woodlands and 11 million acres are classified as forestlands. Two and one-half million acres are managed under the Oregon and California (O&C) Grant Lands program, while the remaining 66.6 million acres are managed under the Public Domain Forest Management program.

Woodlands are defined as land with 10% or more cover of low-stature tree species not typically used in commercial wood products, including land that formerly had such tree cover and will be naturally or artificially regenerated. Forestland is defined as land that has 10% or more cover of tall-stature tree species typically used in commercial wood products, including land that formerly had such tree cover and will be naturally or artificially regenerated.

Approximately 36.5 million acres of forestlands and woodlands are managed by the BLM in Alaska. These consist primarily of black spruce (14.7 million acres) and white spruce (17.2 million acres) woodlands. The remaining 4.6 million acres consist of many different forest types, including paper birch, aspen, balsam poplar, mountain hemlock and Sitka spruce.

Approximately 16 million of the 32 million acres of BLM forestlands and woodlands found in the remaining 16 western states consist of pinyon/juniper woodlands, where a mix of pinyon and juniper tree species predominates. Approximately 2.7 million acres are comprised of the Douglas-fir forest type, 1.9 million acres are the western juniper forest type, 1.1 million

acres are the ponderosa pine forest type, and 0.3 million acres each are the lodgepole pine and aspen forest types. The remaining 10 million acres consist of a wide variety of forest and woodland types.

The Public Domain Forest Management and O&C Grand Lands programs are responsible for timber and non-timber special forest product sales, reforestation efforts, fish and wildlife habitat improvement, and forest vegetation composition and structure improvements intended to increase diversity and productivity of forest landscapes, as well as their resiliency in response to disease, insects, and wildfire.

The FLPMA and BLM Manual 5000-1, Forest Management Public Domain (USDI BLM 1991c), direct the policy of the Public Domain Forest Management program, including requirements for planning and implementing forestry and woodland management projects.

Management of the O&C Grant Lands program is authorized under *The Oregon and California Grant Lands Act of 1937* (43 U.S.C. 1181). The FLPMA applies to all public lands, including the O&C grant lands by definition (§103(e)). However, §701(b) of FLPMA (43 USC 170) provides that if any provision of FLPMA is in conflict with or inconsistent with the *Oregon and California Grant Lands Act* and *Coos Bay Wagon Road Act*, insofar as they relate to management of timber resources and disposition of revenue from lands and resources, the latter Acts will prevail.

Treatments that are addressed in this PER include: 1) reducing plant competition to enhance the growth of desired tree species and structures, 2) managing forest stands to provide habitat for wildlife and prevent epidemic insect or disease outbreaks, and 3) managing vegetation that could serve as fuel for wildfires. In 2006, the program implemented forest restoration treatments on 31,948 acres and forest management treatments on 28,644 acres (USDI BLM 2006d). Sales of timber, wood products, and non-timber special forest products totaled nearly $36.1 million during FY 2005 (USDI BLM 2006d).

Riparian Management

The BLM manages over 23 million acres of riparian and wetland areas, comprising about 9% of public lands, and providing habitat for roughly 80% of the fish and wildlife species on public lands. This Riparian Management program's responsibilities include watershed, riparian, and wetland inventories, assessments, maintenance, restoration, and reconstruction. During 2005, the program assessed the condition of over 4,300 miles of streams, implemented enhancement projects on approximately 310 acres of wetlands and 542 miles of streams, and monitored over 8,200 acres of lakes and wetlands and 2,380 miles of streams (USDI BLM 2006c).

Wildlife and Fisheries Management

The Wildlife Management and Fisheries Management programs are responsible for managing and protecting habitats on public lands for wildlife, fish, and plant species that are federally-listed threatened or endangered species, or other sensitive species (collectively referred to as "special status" species), as well as the more common fish and wildlife. Activities conducted by the programs include wildlife, fish, and plant inventories; habitat management plan development; habitat restoration projects, such as vegetation along streambanks; and weed control.

The Wildlife Management and Fisheries Management programs support the Great Basin Restoration and the Conservation of Prairie Grasslands initiatives. In 2000, the BLM implemented the Great Basin Restoration Initiative, a regional restoration strategy to restore and enhance nearly 70 million acres of sagebrush habitat in Nevada, Utah, Oregon, and Idaho, and California. The focus of this effort is to prevent much of the land burned in wildfires from being overwhelmed by annual grasses and noxious weeds. The same year, the BLM also initiated the Conservation of Prairie Grasslands initiative to protect and maintain important grasslands on approximately 15 million acres of short- and mixed-grass prairie in a 7-state area that extends from Canada to Mexico. Both efforts focus on managing healthy landscapes and protecting and restoring habitats to benefit wildlife. The Wildlife Management and Fisheries Management programs are also responsible for managing subsistence uses on public lands in Alaska.

During FY 2005, the programs inventoried nearly 4.7 million acres of wildlife habitat and applied treatments on nearly 166,000 acres of shrubland/grassland vegetation. The BLM also restored or enhanced 1,015 miles of streams and 9,160 acres of upland habitat (USDI BLM 2006c). In addition, the programs monitored over 10.4 million acres of habitat.

Threatened and Endangered Species Management

The Threatened and Endangered Species program is responsible for the conservation and protection of plants and animals that are listed, proposed for listing, or candidates for listing under the ESA, as well as species designated as special status by the BLM. The program inventories and monitors populations of special status species, develops recovery plans and conservation strategies, restores habitat, and reintroduces special status species into areas where they were once found. Examples of recent activities conducted by the program include vegetation treatments to benefit ESA-listed plant and animal species at the West Eugene Wetlands in Oregon, a semi-captive breeding program for the Sonoran pronghorn, and desert tortoise habitat monitoring in California.

Wild Horse and Burro Management

The Wild Horse and Burro Management program is responsible for implementing the Wild Free Roaming Horse and Burro Act and currently manages about 31,000 wild horses and burros on public lands. The goals of the program are to manage wild horses and burros as an integral part of the natural system of public lands under the principle of multiple uses; to protect wild horses and burros from unauthorized capture, branding, harassment or death; and to ensure humane care and treatment of wild horses and burros. The BLM manages wild horse and burro populations by monitoring the animals, establishing appropriate management levels, and removing excess animals when the management level is exceeded. During FY 2005, over 5,700 animals were adopted by the public (USDI BLM 2006d).

Cultural Resources Management, Paleontology, and Tribal Consultation

There are an estimated 4 million archeological and historical properties, millions of archaeological and historical artifacts, and thousands of paleontological (fossil) localities on public lands. The Cultural and Fossil Resources and Tribal Consultation program is responsible for the study, evaluation, protection, management, stabilization and inventory of these paleontological, historical, and archeological resources. The program also ensures the close consultation with tribal and Alaskan native governments, as required by law, for the maintenance, preservation, and promotion of native cultural heritage and resources, including plant and animal subsistence resources. During FY 2005, the BLM restored and protected 627 at-risk cultural and paleontological properties, and conducted 62,510 acres of cultural and paleontological resource inventory (USDI BLM 2006b).

The BLM currently manages numerous Areas of Critical Environmental Concern (ACECs), many of which have a cultural resources basis for this designation. These include the Biscuitroot Cultural ACEC in eastern Oregon, for traditional plant gathering, and the Sears Point ACEC in southwestern Arizona, for rock art and historic trails. Oregon's Yaquina Head Outstanding Natural Area, the BLM's only Outstanding Natural Area, contains the Yaquina Head Lighthouse, a significant cultural property.

Recreation Management

The Recreation Management program, which is comprised of the Wilderness Management and Recreation Resource Management subprograms, is responsible for resource-related recreational activities on public lands. The program manages developed and undeveloped recreational facilities, which involve various types of maintenance and vegetation control. These facilities include nearly 14 million acres of National Conservation Areas, 4.8 million acres of National Monuments, 7.2 million acres of Wilderness Areas, and 14.2 million acres of Wilderness Study Areas, which are part of the BLM's National Landscape Conservation System. This program is also involved in evaluating resources associated with 2,061 miles of rivers protected under the Wild and Scenic Rivers Act, and maintaining vegetation along 5,470 miles of scenic trails (USDI BLM 2006c, d).

Energy and Minerals Management

The Energy and Minerals Management program is responsible for managing oil, gas, geothermal, and mineral development on public lands. The BLM leases lands for development, issues permits for post-lease actions such as drilling, and monitors management activities on leases. Public lands produce over 40% of the Nation's coal, 11% of its natural gas, and 5% of its oil. The BLM issued nearly 3,520 oil and gas leases and nearly 7,740 permits to drill during FY 2005, and in 2004, energy and mineral development is projected to generate $1.4 billion through royalties, rents, bonuses, sales, and fees (USDI BLM 2006c).

Energy and mineral development and operation often involve site disturbance, which can result in invasion of the site by undesired vegetation. Management activities

center on the prevention and detection/eradication of undesirable vegetation, and treatment or control when these are not sufficient. The Energy and Minerals Management program also conducts extensive rehabilitation of disturbed lands.

Realty and Ownership Management

Under FLPMA and Mineral Leasing Act provisions, the Realty and Ownership Management program issues ROW grants to authorize the construction, operation, and maintenance of petroleum pipelines, power lines, energy development and distribution facilities, roads, and communication sites. Over the past 2 years, the BLM processed approximately 4,500 ROW actions annually. In FY 2005, there were nearly 88,000 existing ROW, totaling over 6.6 million acres on public lands, with nearly half of these in New Mexico and Wyoming (USDI BLM 2006c).

Vegetation treatments on ROW are necessary to suppress vegetation that restricts vision or presents a safety or fire hazard. Trees can provide direct or indirect contact with power lines, creating electrical shock and powerline outages, and often causing wildfires. Removal of vegetation is also necessary to maintain drainage ditches associated with these facilities, and to prevent vegetation from encroaching on sites. A primary goal of vegetation control on ROW involves the control of noxious weeds and other invasive or nonnative species.

The BLM maintains and operates approximately 4,000 buildings and nearly 700 administrative sites (USDI BLM 2006c). Buildings on public lands range from complex office buildings and large visitor centers to small restrooms and well houses. Administrative facilities include, but are not limited to, office complexes, fire stations, interagency dispatch centers, internal communication sites, wareyards, equipment maintenance shops, and field camps.

The BLM is responsible for maintaining 394 recreation fee sites, 2,989 non-fee recreation sites, 497 campgrounds with 17,000 campsites, 368 boat ramps, and 87 interpretive centers or contact stations. The BLM administers over 76,000 miles of roads. In addition, the BLM is responsible for a portion of the maintenance on numerous facilities jointly held with other federal, state, county, or private entities (USDI BLM 2006c). At these sites, vegetation management focuses on controlling vegetation that can pose a safety or fire hazard, or is not aesthetically pleasing. The BLM uses premergence and postemergence herbicides to control emerging vegetation.

Vegetation Treatment Planning and Management

The BLM's *Strategic Plan* (USDI BLM 2000a); *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-Year Comprehensive Strategy Implementation Plan* (USDI and USDA 2002); *Partners Against Weeds: An Action Plan for the Bureau of Land Management* (USDI BLM 1996), and *Pulling Together: National Strategy for Invasive Plant Management* (USDI BLM 1998a) identify broad objectives for management of vegetation on public land, while treatment activities at the local level are guided by the goals, standards, and objectives of land use plans developed for each BLM field office.

Although vegetation management actually occurs at the local level, policies established at the national level help direct local efforts. Examples of national policy direction designed to improve vegetation management efforts include development of rangeland health standards and development of assessments and evaluations for land, water, air, and vegetative health (USDI BLM 2002b). These assessments provide information that is used to ascertain achievement of land health standards and to identify causes for not meeting standards. These assessments are used to help identify restoration activities and establish restoration priorities.

Land Use Planning

Land use planning decisions are the basis for every on-the-ground action the BLM undertakes. Land use plans, usually in the form of RMPs, ensure that public lands are managed in accordance with the intent of Congress, as stated in FLPMA (43 USC 1701 et seq), under the principles of multiple use and sustained yield. As required by FLPMA and BLM policy, "public lands must be managed in a manner that protects the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archaeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish, and wildlife and domestic animals; that will provide for outdoor recreation and human occupancy and use; and that recognizes the Nation's need for domestic sources of minerals, food, timber, and fiber from the public

lands by encouraging collaboration and public participation throughout the planning process."

Land use plans guide land use and vegetation management decisions within the geographic area they cover, and provide specific goals, standards, objectives, and expected outcomes that apply to vegetation treatment projects and activities. These plans identify important local resources to be protected, identify historic, current, and future desired conditions for vegetation, and describe land use activities and levels that are appropriate to maintain healthy vegetation. Wise planning also considers the importance of other natural resources, such as water and soil, when developing vegetation restoration strategies. In addition, BLM land use plans identify transportation facilities, utility corridors, and other infrastructure development on the public lands that is likely to receive some form of vegetative treatment.

To assist with vegetation management planning, key resource elements such as plant community types, aquatic habitats, sensitive areas, and invasive species concentration areas, are inventoried and mapped regionally and district-wide. Inventories and maps allow field managers to identify areas of high ecological integrity; to ensure that there is suitable habitat for wide-ranging species; to identify areas where land uses may be incompatible with long-term ecosystem health; and to identify areas that could benefit from improved management. Inventories and mapping are also done at the local level to help managers better understand how proposed projects fit in with vegetative conditions on a larger scale, such as within ecoregions or watersheds. The BLM also cooperates with other agencies, organizations, and landowners in regional planning efforts, including establishment of Cooperative Weed Management Areas (CWMAs).

Site Selection and Treatment Priorities

Upon approval of a land use plan, subsequent implementation decisions are often put into effect by developing implementation plans. Implementation plans, also referred to as "activity plans," tend to focus on multiple resources, and include vegetation treatment activities within a BLM field office jurisdiction. Implementation plans are made with the appropriate level of NEPA analysis; implementation decisions are usually made by BLM field managers. Implementation decisions identify site-specific vegetation management practices to achieve desired outcomes laid out in the land use plans. Some examples of practices include fuels treatments and integrated vegetation management techniques for weed infestations.

General Site Selection and Treatment Priorities

Several factors influence where treatments will occur and treatment priorities:

- Statutory mandates, including the FLPMA, ESA, HFRA, and Taylor Grazing Act.
- Program guidance including such initiatives as the Healthy Forests Initiative and the Great Basin Restoration Initiative.
- Goals of the Strategic and Annual Performance Plans.
- Existing risks to resources.
- Likelihood of success in restoring natural biotic communities.
- Cost-effectiveness of actions.

National priorities have been established for various BLM vegetation management programs. These priorities were developed for use in conjunction with state and local office priorities for meeting restoration goals, and address site-specific conditions and/or issues as laid out in the land use plan. For example, the following treatment priorities have been established to promote integrated efforts across BLM resource programs that manage vegetation:

- WUI community protection treatments that are designed to reduce the risk of wildfire to the community and/or its infrastructure developed collaboratively with the community.
- Treatments to restore or maintain healthy, diverse, resilient, and productive native plant communities.
- Special status species habitat improvement projects designed to improve or protect special status fish, wildlife, and plant habitat.
- Treatments that will be planned, implemented and/or monitored using funding from multiple sources, both internal and external.
- Landscape treatments (>1,000 acres for mechanical and >4,500 acres for prescribed fires) coordinated across field office boundaries to improve treatment effectiveness.

- Contracted treatments that support economic opportunities for rural communities and/or high potential to use stewardship contracting authorities.
- Treatments that have a high potential for woody biomass utilization.

Weed Treatment Site Selection and Treatment Priorities

For noxious weeds and invasive plants, vegetation treatment priorities identified in the *EIS Vegetation Treatment on BLM Lands in Thirteen Western States* (USDI BLM 1991a) are still applicable. They are:

- Take actions to prevent or minimize the need for vegetation controls, where feasible.
- Use effective nonchemical methods of vegetation control, where feasible.
- Use herbicides only after considering the effectiveness of all potential methods.

Development of a weed management strategy is set up at the local level and aligned with the land use planning objectives.

Actions to prevent or minimize the need for vegetation control can include protecting intact systems; maintaining conditions that have led to healthy lands (e.g. allowing natural fires to burn); reducing the impact of ongoing activities (e.g., improving grazing management practices); and applying mitigation measures to new projects to minimize soil and vegetation disturbance and avoid introductions of invasive species.

If treatment is required, efforts are focused on activities that restore natural ecosystem processes, and on ventures that are likely to succeed and provide the greatest benefits with the least expenditure of capital. Also beneficial to treatment success is site-specific analysis that includes 1) a determination of site potential under current circumstances, 2) an evaluation of land health based on land assessment studies, 3) an assessment of causes of land degradation, 4) an assessment of the likely effectiveness of treatment methods, and 5) an evaluation of the success of restoration efforts on similar types of land.

Several management objectives are considered when determining appropriate treatment of an infestation.

- Containment to prevent weed spread from moving beyond the current infestation perimeter;
- Control to reduce the extent and density of a target weed;
- Eradication to completely eliminate the weed species including reproductive propagules (this is usually only possible with small infestations); and
- Restoration of native plant communities and habitats using native species that are adapted to the project site to compete with invasives.

Several variables are considered when determining what, when, and how weed populations should be treated. These include, but are not limited to:

- The species – is it an aggressive non-native species that could be on a state noxious weed list or an adjacent state's noxious weed list, or that could be a species known for altering plant communities or ecological processes on a regional basis? If a species is native to a project area, how does current management influence the increase of the species beyond acceptable levels?
- Location – is the infestation found in a special management area, in a formerly uninfested area, or upslope/upstream from current treatments (i.e., could the species reinfest treated areas)? Does the infestation pressure or negatively impact special status plants or their habitats?
- Extent – is the infestation at a size where eradication is possible, in an area where other infestations are numerous, or of a size that may not be able to be eradicated, but can be contained or controlled to some extent? Is the extent of the infestation so large that one treatment would cover all of the known locations of an endemic species or its required resources?

The following suggests a decision process for prioritizing weed treatments in order to focus efforts towards success. It provides broad guidance to be adapted to the local level based on species, size, and extent of infestations. Priorities are then matched with the management objectives listed above.

1. Highest Priority: New aggressive infestations in an uninfested area or small infestations in areas of special concern (e.g., wilderness, research natural areas). Management objective: Eradicate.

2. Higher Priority: Areas of high traffic or sources of infestation and larger infestations in areas of special concern. Management objective: Control.

3. High Priority: Existing large infestations or roadside infestations where spread can be checked or slowed. Management objective: Contain.

The overriding goal is to prioritize treatment methods based on their effectiveness and likelihood to have minimal impacts on the environment, and to restore desirable vegetation on lands where necessary (i.e., where desired vegetation cannot reestablish naturally).

Vegetation Treatment Methods

The BLM treats vegetation using fire, mechanical and manual methods, biological treatments, and herbicides. In an integrated vegetation management program, each management option is considered, recognizing that no one management option is a stand-alone option and that each has strengths and weaknesses. Utilizing the strengths of each allows for a more effective and environmentally sound program. When the BLM plans vegetation management projects, all control methods should be available for use, allowing the BLM to select the one method, or the combination of methods, that optimizes vegetation control with respect to environmental concerns, effectiveness, and cost of control.

No individual method will control undesirable vegetation in a single treatment; diligence and persistence will be required over a number of years to subdue vegetation such as weeds. The success of different treatment methods depends on the type of vegetation being controlled. It is important to think of these treatment methods as they relate to specific characteristics of weeds and other vegetation.

Vegetation Treatment Method Selection

Vegetation treatment methods are selected based on several parameters, which may include the following:

- Management program/objective for the site.
- Historic and current conditions.
- Opportunities to prevent future problems.
- Opportunities to conserve native and desirable vegetation.
- Effectiveness and cost of the treatment methods.
- Success of past restoration treatments or treatments conducted under similar conditions or recommendations by local experts.
- Characteristics of the target plant species, including size, distribution, density, life cycle, and life stage in which the plant is most susceptible to treatment.
- Non-target plant species that could be impacted by the treatment.
- Land use of the target area.
- Proximity to communities.
- Slope, accessibility, and soil characteristics of the treatment area.
- Weather conditions at the time of treatment, particularly wind speed and direction, precipitation prior to or likely to occur during or after application, and season.
- Proximity of the treatment area to sensitive areas, such as wetlands, streams, or habitat for plant or animal species of concern.
- Potential impacts to humans and fish and wildlife, including non-game species.
- Need for subsequent revegetation and/or restoration.

These parameters are considered before a treatment method is selected (USDI BLM 1991a). For most vegetation treatment projects, pretreatment surveys are conducted before selecting one or more treatment methods. These surveys involve the consideration of all feasible treatments, including their potential effectiveness based on previous experience, and best available science, impacts, and costs. Before vegetation treatment or ground disturbance occurs, the BLM consults specialists or databases for information on sensitive areas within the project area. The site may have to be surveyed for listed or proposed federal threatened or endangered species and for evidence of

cultural or historic sites. In some cases, areas may receive one or more treatments in combination, such as prescribed burning followed by an herbicide application, and some areas may be treated using one or more treatment methods over several years.

Fire Use

Fire use includes prescribed fire and wildland fire use for resource benefits. Prescribed fire is the intentional application of fire to wildland fuels under specified conditions of fuels, weather, and other variables. The intent is for the fire to stay within a predetermined area to achieve site-specific resource management objectives. Prescribed and wildland fire use for resource benefit are important tools to maintain landscapes in healthy condition. These methods may be used to control vegetation; enhance the growth, reproduction, or vigor of certain species; manage fuel loads; and maintain vegetation community types that meet multiple-use management objectives (USDI BLM 1991a). Burning may be used prior to other treatments to remove vegetation that reduces the effectiveness of various treatments, including herbicide applications (Rees et al. 1996). Often, mechanical treatments are conducted before a burn to reduce the amount of biomass so that the subsequent fire will not burn so intensely so as to kill desirable vegetation.

Prescribed fire was used on nearly 212,000 acres of public lands in 2003. Most acres were burned in Idaho (54,620), Oregon (40,459), New Mexico (26,869), and Arizona (26,127; USDI BLM 2004c).

In areas where there is no threat to human life or property, wildland fires are utilized for resource benefit to maintain ecosystems that are functioning within their normal fire regime. These fires must meet specific environmental prescriptions, and be thoroughly evaluated for potential risk, before being managed to benefit the resource. They are utilized only in pre-planned areas and when there are adequate fire management personnel and equipment available to achieve defined resource objectives.

The BLM develops land use plans to establish and define resource management objectives for a particular area (USDI BLM 1998b). All use of fuels treatments and prescribed fire will support land and resource management plans. Agency-specific land management plans are the documents that initiate, analyze, and provide the basis for conducting fuels treatment activities and using prescribed fire to meet resource objectives.

Treatments are implemented in accordance with the BLM's Prescribed Fire Management Policy. The Fire Management Plan (FMP) serves as the program strategy document for fuels treatments and prescribed fire activities. The FMP captures and quantifies the overall fuels management program needs of the field office. The FMP identifies how fuels treatments, fire use, and other fire management strategies will be used to meet the overall land management goals identified in land use plans. The FMP also identifies areas where the use of wildland fire for resource benefits is acceptable.

The Prescribed Fire Plan is the contract between a Line Officer and Burn Boss to conduct a burn safely to achieve predetermined objectives. Prescribed fire projects must be implemented in compliance with the written plan.

A Wildland Fire Implementation Plan (WFIP) is prepared for all wildland fires that are managed for resource benefit. The WFIP is an operational plan for assessing, analyzing, and selecting strategies for wildland fire use. It is progressively developed, and documents appropriate management responses for any wildland fire managed for resource benefits.

Several factors are considered when designing a burn plan and implementing a prescribed burn. These factors include weather conditions, vegetation types and density, slope, fuel moisture content, time of year, risks to dwellings and property, alternative treatment methods, and potential impacts on air quality, land use, cultural resources, and threatened and endangered species.

Hand-held tools, such as drip torches, propane torches, diesel flame-throwers, and flares, may be used to start a prescribed fire. Mass ignition techniques, which include terra-torches and heli-torches, release an ignited gelled fuel mixture onto the area to be treated. Helicopters may also be used to drop hollow polystyrene spheres containing potassium permanganate that are injected with ethylene glycol immediately before ignition. The sphere ignition method is best used for spot-firing programs.

Prescribed fire can be used in some situations where some other treatment methods are not feasible due to soil rockiness, slope steepness, or terrain irregularity, although prescribed fire is limited to situations where adequate fuel is available to carry the fire. It is also

relatively inexpensive to treat vegetation using fire ($20 to $500 per acre, with higher costs associated with treating forestlands in California and Oregon).

The use of prescribed fire comes with a risk of the fire getting out of control and damaging property and endangering human life, although <1% of BLM ignited prescribed fires exceed control and are declared wildfires. Thus, chemical, biological, mechanical and manual methods, instead of fire, are often used to control vegetation near communities. In some situations, prescribed fire can encourage the germination and establishment of weeds if the treatment site is not treated with herbicides or revegetated after fire use.

Mechanical Treatment

Mechanical treatment involves the use of vehicles such as wheeled tractors, crawler-type tractors, or specially designed vehicles with attached implements designed to cut, uproot, or chop existing vegetation. The selection of a particular mechanical method is based on the characteristics of the vegetation, seedbed preparation and revegetation needs, topography and terrain, soil characteristics, climatic conditions, and an analysis of the improvement cost compared to the expected productivity (USDI BLM 1991a). Mechanical methods that may be used by the BLM include chaining, root plowing, tilling and drill seeding, mowing, roller chopping and cutting, blading, grubbing, and feller-bunching. As new technologies or techniques are developed, they could be used if their impacts are similar to or less than those associated with the methods listed below.

Chaining consists of pulling heavy (40 to 90 pounds per link) chains in a "U" or "J" shaped pattern behind two crawler-type tractors. The chain is usually 250 to 300 feet long and may weigh as much as 32,000 pounds. The width of each swath varies from 75 feet to 120 feet. Chain link size, modifications to links, and operation of the crawler tractors determine the number and size of trees and shrubs that are removed and the effects on understory species. Chaining can be conducted during the appropriate season to benefit soil stability and plant seeding, and reduce the invasion of weeds (Monsen et al. 2004).

Chaining works best for crushing brittle brush and uprooting woody plants. Chaining can be done on irregular, moderately rocky terrain, with slopes of up to 20%. Chaining may cause soil disturbance, but the plant debris can be left in place to minimize runoff and erosion, shade the soil surface, and maintain soil moisture and nutrient recycling. Alternatively, the debris can be burned to facilitate seeding, improve scenic values, and eliminate potential rodent habitat. Chaining is a cost-effective means of incorporating seed into soil, especially in burned areas. Chaining provides a variety of seeding depths and microsites, as well as improves ground cover and forage production. Recent studies have shown improved seedling establishment on chained sites and less downy brome establishment 3 years after fire in chained sagebrush and pinyon-juniper habitats (Ott et al. 2003).

Tilling involves the use of angled disks (disk tilling) or pointed metal-toothed implements (chisel plowing) to uproot, chop, and mulch vegetation. This technique is best used in situations where complete removal of vegetation or thinning is desired, and in conjunction with seeding operations. Tilling leaves mulched vegetation near the soil surface, which encourages the growth of newly planted seeds. Tilling is usually done with a brushland plow, a single axle with an arrangement of angle disks that covers about 10-foot swaths. An offset disk plow, which consists of multiple rows of disks set at different angles to each other, is pulled by a crawler-type tractor or a large rubber tire tractor. This method is often used for removal of sagebrush and similar shrubs and works best on areas with smooth terrain, and deep, rock-free soils. Chisel plowing can be used to break up soils such as hardpan.

Often, drill seeding is conducted along with tilling. The seed drills, which consist of a series of furrow openers, seed metering devices, seed hoppers, and seed covering devices, are either towed by or mounted on a tractor. The seed drill opens a furrow in the seedbed, deposits a measured amount of seed into the furrow, and closes the furrow to cover the seed.

Mowing tools, such as rotary mowers or straight-edged cutter bar mowers, can be used to cut herbaceous and woody vegetation above the ground surface. Mowing is often done along highway ROW to reduce fire hazards, improve visibility, prevent snow buildup, or improve the appearance of the area. Mowing is also used in sagebrush habitats to create a mosaic of uneven aged stands and enhance wildlife habitat. Mowing is most effective on annual and biennial plants (Rees et al. 1996). Weeds are rarely killed by mowing, and an area may have to be mowed repeatedly for the treatment to be effective (Colorado Natural Areas Program 2000). However, the use of a "wet blade," in which an herbicide flows along the mower blade and is applied

directly to the cut surface of the treated plant, has greatly improved the control of some species. In addition, chipping equipment can be used to cut and chip vegetation.

Roller chopping tools are heavy bladed drums that cut and crush vegetation up to 5 inches in diameter with a rolling action. The drums are pulled by crawler-type tractors, farm tractors, or a special type of self-propelled vehicle designed for forested areas or range improvement projects.

During blading, a crawler type tractor blade shears small brush at ground level. The topsoil can be scraped with the brush and piled into windrows during this operation. Blading use is limited to areas where degradation to the soil is acceptable, such as along ROW or in borrow ditches (USDI BLM 1991a).

Grubbing is done with a crawler-type tractor and a brush or root rake attachment. The rake attachment consists of a standard dozer blade adapted with a row of curved teeth projecting forward at the blade base. Brush is uprooted and roots are combed from the soil by placing the base of the blade below the soil surface. Grubbing greatly disturbs perennial grasses, so grubbed areas are usually reseeded to prevent extensive runoff and erosion (USDI BLM 1991a).

Feller-bunchers are machines that grab trees, cut them at the base, pick them up, and move them into a pile or onto the bed of a truck (Bonneville Power Administration [BPA] 2000). Feller-bunchers are used in forest thinning to remove potential hazardous fuels. Large chippers, or "tub-grinders," are often used to chip the limbs, bark, and wood of trees to generate mulch or biomass, which can be used in power generation facilities.

Mechanical methods are effective for removing thick stands of vegetation. Some mechanical equipment can also mulch or lop and scatter vegetation debris, so debris disposal is taken care of while the vegetation is removed. Mechanical methods are appropriate where a high level of control over vegetation removal is needed, such as in sensitive wildlife habitats or near homesites, and are often used instead of prescribed fire or herbicide treatments for vegetation control in the WUI.

Unless used with follow-up herbicide treatments, mechanical treatments have limited use for noxious weed control, as the machinery tends to spread seeds and not kill roots. Mechanical vegetation control costs from $100 to $600 per acre for equipment and labor (BPA 2000). Additionally, repeated mechanical treatments are often necessary due to residual weed seed in the seed bank.

Manual Treatment

Manual treatment involves the use of hand tools and hand-operated power tools to cut, clear, or prune herbaceous and woody species. Treatments include cutting undesired plants above the ground level; pulling, grubbing, or digging out root systems of undesired plants to prevent sprouting and regrowth; cutting at the ground level or removing competing plants around desired species; or placing mulch around desired vegetation to limit competitive growth (USDI BLM 1991a).

Hand tools used in manual treatments include the handsaw, axe, shovel, rake, machete, grubbing hoe, mattock (combination of cutting edge and grubbing hoe), pulaski (combination of axe and grubbing hoe), brush hook, and hand clippers. Power tools such as chain saws and power brush saws are also used, particularly for thick-stemmed plants.

Manual treatments, such as handpulling and hoeing, are most effective where the weed infestation is limited and soil types allow for complete removal of the plant material (Rees et al. 1996). Additionally, pulling works well for annual and biennial plants, shallow-rooted plant species that do not resprout from residual roots, and plants growing in sandy or gravelly soils. Repeated treatments are often necessary due to soil disturbance and residual weed seeds in the seed bank.

Manual techniques can be used in many areas and usually with minimal environmental impacts. Although they have limited value for weed control over a large area, manual techniques can be highly selective. Manual treatment can be used in sensitive habitats such as riparian areas, areas where burning or herbicide application would not be appropriate, and areas that are inaccessible to ground vehicles (USDI BLM 1991a).

Manual treatments are expensive and labor intensive, compared to other vegetation management methods such as prescribed burning and herbicide application. Typical manual vegetation control costs range from $70 to $700 per acre. Manual methods may also be more dangerous for the workers involved in implementation because of the sharp tools and the difficulties associated with working conditions (e.g., steep terrain with slippery ground cover). Some weeds may contain potentially toxic or hazardous compounds. While

manual techniques may not be very efficient or cost-effective over large areas, they may be very useful for highlighting specific invasive species problems, and for educating public land users.

Biological Control

Biological control involves the intentional use of domestic animals, insects, nematodes, mites, or pathogens (agents such as bacteria or fungus that can cause diseases in plants) that weaken or destroy vegetation (USDI BLM 1991a, BPA 2000). Biological control is used to reduce the targeted weed population to an acceptable level by stressing target plants and reducing competition with the desired plant species.

Domestic animals, such as cattle, sheep, or goats, control the top-growth of certain non-native invasive and noxious weeds which can help to weaken the plants and reduce the reproduction potential. The animals benefit by using the weeds as a food source and, after a brief adjustment period, can consume 50% or more of their daily diet of the weed, depending on the animal species (Tu et al. 2001).

Cattle primarily eat grass, but also eat some shrubs and forbs. Sheep consume many forbs, as well as grasses and shrubs, but tend not to graze an area uniformly. Goats typically eat large quantities of woody vegetation as well as forbs, and tend to eat a greater variety of plants than sheep (USDI BLM 1991a; Tu et al. 2001). Goats and sheep are effective control agents for leafy spurge, Russian knapweed, toadflax, other weed species, and some types of shrubs (Colorado Natural Areas Program 2000).

The use of livestock grazing to help control undesirable vegetation involves more than just authorizing grazing for the area to be treated. A general grazing authorization would only rarely provide significant control of undesirable vegetation. The use of livestock to control undesirable vegetation requires "prescribed grazing." In prescribed grazing, the kind of animals and amount and duration of grazing are specifically designed to help control a particular species of plant while minimizing the impacts on perennial native vegetation that is needed to help reduce the likelihood of reinvasion by undesirable plant species.

In order for prescribed grazing to be effective, the right combination of animals, stocking rates, timing, and rest must be used. Grazing by domestic animals should occur when the target species is palatable and when feeding on the plants can damage them or reduce viable seeds. Additionally, grazing should be restricted during critical growth stages of desirable competing species. When desirable species are present, there must be adequate rest following the treatment to allow the desirable species to recover.

Whenever the use of livestock to control undesirable vegetation is being considered, the needs of the domestic animals as well as the other multiple use objectives for the area must be considered. A herder, fencing, or a mineral block may be required to keep the animals within the desired area. Many weed species are less palatable than desired vegetation, so the animals may overgraze desired vegetation rather than the weeds. Additionally, some weeds may be toxic to certain livestock and not to others, which will influence the management option selected (Tu et al. 2001). Proper management of the domestic animals is extremely important if this method of treatment is to be successful (Olson 1999).

Caution should be used whenever grazing or any other vegetation control is prescribed near riparian areas, in steep topography, or in areas with highly erodible soils. Weed seeds may still be viable after passing through the digestive tract of animals, so the animals should not be moved to weed-free areas until ample time has passed for all seeds to pass through their systems. Seeds can also travel on the animals' fur (Tu et al. 2001).

Plant-eating insects, nematodes, mites, or pathogens affect plants directly, by destroying vital plant tissues and functions, and indirectly, by increasing stress on the plant, which may reduce its ability to compete with other plants (BPA 2000). Often, several biological control agents are used together to reduce undesired vegetation density to an acceptable level.

Biological control agents currently used by the BLM have been tested by the USDA Agricultural Research Service to ensure that they are host specific and will feed only on the target plant and not on crops, native flora, or endangered or threatened plant species.

Testing of biological control agents is time consuming and expensive. Test results are reported in an environmental assessment, or a risk assessment, which is a measurement of risk of using the organism. The Plant Pest Quarantine Branch of the USDA Animal and Plant Health Inspection Service (APHIS) is responsible for finding and testing suitable biological controls, and authorizing permits to transport and release biological controls into the U.S. Organizations, such as the USDA Agricultural Research Service, CABI Bioscience-

Europe and Canada, and Canadian agencies and universities are working to collect, identify, screen, and approve biological control agents to support the BLM's integrated weed management program.

The approval process for a biological control agent can be very complicated. Researchers wanting to use a candidate biological control agent should submit a proposed test plant list to the Technical Advisory Group for Biological Control Agents of Weeds (USDA APHIS 2002). This step includes consulting with the USFWS to determine whether threatened, endangered, or candidate species should be considered in the test plant list. The researcher must apply for a permit to import the agent into the U.S. In addition, if the researcher proposes to use a pathogen for weed biological control, he must obtain approval from the USEPA, which regulates microbial pathogens as biological pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act of 1972. Once a biological control organism has been approved for release, its release can only occur in states that have been covered under a NEPA assessment and have consulted with the USFWS. More information on the testing process is available at: http://www.aphis.usda.gov. A list of biological control agents approved for use is available at: http://www.aphis.usda.gov/ppq/permits/tag/petition.html.

Once a biological control agent becomes established, it can reproduce and increase its numbers and continue to affect the target organism. Agents are also often fairly mobile and can seek out new host plants (Rees et al. 1995, 1996). However, it may take as many as 15 to 20 years for the agents to establish themselves and bring about the desired level of control. Treatments involving biological control agents are most suitable for large sites where the target plant is well established and very competitive with native species. It is unlikely that biological control agents will eradicate a pest plant, because as populations of the host plant decrease, populations of the agent will also decline.

Treatment of noxious weeds using domestic animals is relatively inexpensive, costing about $12 to $15 per acre. Biological control costs using insects, nematodes, mites, or other pathogens range from $80 to $150 per release for ground applications and $150 to $300 for aerial releases (BPA 2000). The cost of this method reflects the limited availability of appropriate control agents and expertise required in dealing with the agents and treating areas. Biological treatments are most effective when followed with other treatments.

Herbicides

As discussed in Chapter 1, this PER focuses primarily on the use of non-chemical means to treat vegetation. A *Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic EIS* has been prepared concurrently with the PER to analyze the effects of herbicide use on humans, plants, and animals (including special status species), and other environmental and social resources associated with public lands. This analysis will provide the basis for a programmatic ESA Section 7 consultation with the USFWS and NMFS for herbicide use as a vegetation control practice, and the potential impacts of these practices on plant and animal species of concern.

Herbicides are chemicals that kill or injure plants. Herbicides can be classified by their mode of action; they include growth regulators, amino acid inhibitors, grass meristem destroyers, cell membrane destroyers, root and shoot inhibitors, and amino acid derivatives, all of which interfere with plant metabolism in a variety of ways (Bussan and Dyer 1999).

Herbicides can be categorized as selective or non-selective. Selective herbicides kill only a specific type of plant. For example, some herbicides used for noxious weed control are selective for broad-leaved plants, so that they can be used to control weeds while maintaining grass species. Glyphosate is non-selective, so it must be used carefully around desirable and non-target plants (Rees et al. 1996).

Herbicide treatments comply with the USEPA label directions and follow BLM procedures outlined in BLM Handbook H-9011-1 (*Chemical Pest Control*), and manuals 1112 (*Safety*), 9011 (*Chemical Pest Control*), and 9015 (*Integrated Weed Management)*, and meet or exceed states' label standards (USDI BLM 1991a). Several herbicide application methods are available. The application method chosen depends upon the treatment objective (removal or reduction); the accessibility, topography, and size of the treatment area; the characteristics of the target species and the desired vegetation; the location of sensitive areas and potential environmental impacts in the immediate vicinity; the anticipated costs and equipment limitations; and the meteorological and vegetative conditions of the treatment area at the time of treatment.

An operational plan is developed and updated for each herbicide project. The plan includes information on project specifications, key personnel responsibilities,

communication procedures, and safety, spill response, and emergency procedures. The plan should also specify minimum widths for buffers between treatment areas and water bodies for non-aquatic use herbicides that comply with BLM policy and label restrictions (BLM Handbook H-9011-1).

Herbicide application schedules are designed to minimize potential impacts to non-target plants and animals, while remaining consistent with the objective of the vegetation treatment program. The application rates depend upon the target species, the presence and condition of non-target vegetation, weather and site conditions, soil type, depth to the water table, presence of other water sources, the label requirements, approved BLM rates, and sensitivity of non-target species.

Herbicides are applied aerially with helicopters or fixed-wing aircraft, and on the ground with vehicles or manual application devices. Operation of helicopters is more expensive than operation of fixed-wing aircraft, but helicopters are more maneuverable and more effective in areas with irregular terrain. Helicopters also are more effective for treating target vegetation in areas with multiple vegetation types.

Manual applications of herbicides are used only in small areas, in areas inaccessible by vehicle, and/or to minimize potential impacts to non-target plants. Herbicides may be applied to green leaves with a backpack applicator or spray bottle, wick (wiped on), or wand (sprayed on). Herbicides can be applied to trees around the circumference of the trunk on the intact bark (basal bark), to cuts in the trunk or stem (frill, or "hack and squirt"), to cut stems and stumps (cut stump), or injected into the inner bark (Tu et al. 2001).

Herbicides can be used selectively to control specific types of vegetation, or nonselectively to clear all vegetation in a particular area. Herbicides can be applied over large areas and in remote locations using aircraft, or applied using spot applications in environmentally sensitive areas. The cost of herbicide application generally ranges from $20 to $250 per acre (BPA 2000).

There are several drawbacks and limitations to herbicide use. Herbicides can damage or kill non-target plants. Herbicides can be toxic or cause health problems in humans, other animals, and other plants. Herbicides must be applied by someone with the appropriate certification identified in state laws and BLM policy (Colorado Natural Areas Program 2000).

Herbicides are applied according to the current label directions. The BLM must comply with changes in label directions, and with state registration requirements.

Herbicide Terminology

Active ingredient (a.i.) is the chemical or biological component that kills or controls the target pest.

Adjuvant(s) are chemicals that are added to the pesticide formulation to enhance the toxicity of the active ingredient or to make the active ingredient easier to handle.

Formulation is the commercial mixture of both active and inactive (inert) ingredients.

Herbicide is a chemical pesticide used to treat vegetation.

Herbicide resistance occurs when naturally occurring heritable characteristics allow individual weeds to survive and reproduce, producing a population, over time, in which the majority of the plants of the weed species have the resistant characteristics.

Inert ingredient(s) are those ingredients that are added to the commercial product (formulation) and are not herbicidally active.

Weed populations may develop a resistance to a particular herbicide over time. Herbicide resistance is the inherited ability of a plant to survive an herbicide application to which the wild-type was susceptible. Resistant plants occur naturally within a population and differ slightly in genetic makeup, but remain reproductively compatible with the wild-type. Herbicide resistant plants are present in a population in extremely small numbers. The repeated use of one herbicide allows these few plants to survive and reproduce. The number of resistant plants then increases in the population until the herbicide no longer effectively controls the weed. Herbicide resistance is not the natural tolerance that some species have to an herbicide. The appearance of herbicide-resistant weeds is strongly linked to repeated use of the same herbicide or herbicides with the same site of action in a monoculture cropping system or in non-crop areas.

There are several things that can be done, and are being done by the BLM, to minimize the potential development of resistant weed species, including, but not limited to the following:

- Rotate herbicides – by understanding the different modes of action of each herbicide

proposed for use on public lands, select the appropriate one to minimize resistance;

- Understand the potential effects of long-term residual herbicides on the selection for resistant weeds, and correctly apply these herbicides with the understanding that they can lead to weed resistance if used yearly for several consecutive years;
- Use mechanical and biological management options to eliminate weed escapes that may represent the resistant population; and
- Keep accurate records of herbicide application.

Herbicides Evaluated in the PEIS

In previous EISs, a total of 25 herbicide active ingredients were reviewed, 22 were evaluated, and 20 are presently approved for use in one or more states (Tables 2-1, 2-2, and 2-3). The decision to approve these herbicides for use on public lands was based on a detailed analysis of the risks to human health and non-target species from the use of these chemicals.

Since the majority of these assessments were completed in the late 1980s, a comprehensive literature review was conducted as part of the PEIS to determine whether there was any significant new information relevant to environmental concerns regarding the continued use of these herbicides (McMullin and Thomas 2000). Local BLM field offices were also consulted for information from field applications suggesting that any of these chemicals should be re-analyzed. If so, a new risk assessment for that active ingredient was completed as part of the PEIS in order to assess whether the BLM should continue its use.

Based on the literature review and information from the field, sulfometuron methyl (Oust®) was found to potentially have significant impacts on non-target vegetation when carried on soil to untreated areas, effects that were not evaluated earlier. Thus, the toxicity and environmental fate of sulfometuron methyl were analyzed in the PEIS. It was determined that the remaining 19 herbicides did not require further analysis for human health risks. However, the BLM determined that the level of analysis contained in the non-target species assessments for fish and wildlife for the previous EISs was inadequate to characterize the risks to species of concern, including anadromous fish.

Since the mid-1990s, the Forest Service conducted ecological risk assessments (ERAs) for nine herbicide active ingredients also used by the BLM: 2,4-D, clopyralid, dicamba, glyphosate, hexazinone, imazapyr, metsulfuron methyl, picloram, and triclopyr. In addition, the Forest Service prepared interactive spreadsheets that allowed the BLM to determine exposure concentrations for plants and animals under different application rates and exposure scenarios for these herbicides. The ERAs and spreadsheets are available on the Internet at the Forest Service Pesticide Management and Coordination website at http://www.fs.fed.us/foresthealth/pesticide/index.shtml.

Information contained in the ERAs was used by the BLM to characterize risks to non-target species from the specific chemicals and is incorporated by reference into the PEIS.

The Forest Service did not conduct ERAs for bromacil, chlorsulfuron, diuron, and tebuthiuron. Thus, the BLM conducted new ERAs for these herbicides as part of the PEIS.

The remaining six active ingredients currently approved for use by the BLM—2,4-DP, asulam, atrazine, fosamine, mefluidide, and simazine—have not been used, or their use has been limited to a very small number of acres, by the BLM for several years, primarily due to the availability of other, more effective approved active ingredients.

In the PEIS, the BLM proposes to use four new herbicide active ingredients that are registered and available for use—diflufenzopyr (as a formulation with dicamba), diquat, fluridone, and imazapic. All four of the herbicides have been deemed effective in controlling vegetation, have minimal effects on the environment and human health if used properly, and are registered (except diflufenzopyr as a stand-alone active ingredient) with the USEPA. Diflufenzopyr is approved as a formulation with dicamba and is labeled as Distinct, but cannot be used as a stand-alone active ingredient by the BLM until it is registered with the USEPA.

The new active ingredients were selected based on: 1) input from BLM field offices on types of vegetation needing control; 2) studies indicating that these active ingredients would be more effective in controlling noxious weeds and other unwanted vegetation targeted for control than active ingredients currently used by the BLM; 3) USEPA approval for use on rangelands, forestlands, and/or aquatic environments (see http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg for information on herbicide registration and fact sheets on all registered products); 4) responses from

herbicide manufacturers to a request from the BLM in October 2001 for a list of herbicides not currently approved for use on public lands that may be appropriate to control vegetation; 5) the ability of the herbicide formulations to be applied on a variety of plant species needing control; 6) the level of risk of the herbicidal formulations to human health and the environment; and 7) the funds available to the BLM to conduct human health and ecological risk assessments of the proposed herbicides.

In order to ensure that the use of these active ingredients is appropriate for public lands, the BLM conducted human health risk assessments (HHRAs) and ERAs to assess the potential for risks to humans and non-target plants and animals, including special status species, from using these active ingredients. The following analyses are presented in Chapter 4, Environmental Consequences, and in appendixes B, C, and D of the Final PEIS: 1) the toxicity and environmental fate of each active ingredient, and of a formulation of diflufenzopyr and dicamba (Overdrive®); 2) risks associated with surfactants found in herbicide formulations and herbicide active ingredient degradates; and 3) the potential for herbicides considered in the PEIS to be endocrine disrupting chemicals.

For new and currently available herbicides that may be proposed for use in the future, the BLM would follow the following steps for conducting risk assessments: 1) assess a product's or a technology's effectiveness for use on target vegetation on public lands; 2) identify the level of data and analysis needed to conduct a human health and ecological risk assessment for that chemical; 3) determine the level of NEPA documentation required to support a decision to use a new product or technology; and 4) consult with the ESA regulatory agencies. These steps are discussed in more detail in Appendix E of the Final PEIS.

Vegetation Treatment Standard Operating Procedures and Guidelines

This section identifies standard operating procedures (SOPs) that would be followed by the BLM to ensure that risks to human health and the environment from treatment actions would be kept to a minimum. Standard operating procedures are the management controls and performance standards required for vegetation management treatments. These practices are intended to protect and enhance natural resources that could be affected by future vegetation treatments.

Prevention of Weeds and Early Detection and Rapid Response

Once weed populations become established, infestations can increase and expand in size. Weeds colonize highly disturbed ground and invade plant communities that have been degraded, but are also capable of invading intact communities. Therefore, prevention, early detection, and rapid response are the most cost-effective methods of weed control. Prevention, early detection, and rapid response strategies that reduce the need for vegetative treatments for noxious weeds should lead to a reduction in the number of acres treated using herbicides in the future by reducing or preventing weed establishment.

As stated in the BLM's *Partners Against Weeds - An Action Plan for the BLM* (USDI BLM 1996), prevention and public education are the highest priority weed management activities. Priorities are as follows:

- Priority 1: Take actions to prevent or minimize the need for vegetation control when and where feasible, considering the management objectives of the site.
- Priority 2: Use effective nonchemical methods of vegetation control when and where feasible.
- Priority 3: Use herbicides after considering the effectiveness of all potential methods or in combination with other methods or controls.

Prevention is best accomplished by ensuring the seeds and vegetatively reproductive plant parts of new weed species are not introduced into new areas.

The BLM is required to develop a noxious weed risk assessment when it is determined that an action may introduce or spread noxious weeds or when known habitat exists (USDI BLM 1992b). If the risk is moderate or high, the BLM may modify the project to reduce the likelihood of weeds infesting the site, and to identify control measures to be implemented if weeds do infest the site.

To prevent the spread of weeds, the BLM takes actions to minimize the amount of existing non-target vegetation that is disturbed or destroyed during project or vegetation treatment actions (Table 2-4). During project planning, the following steps are taken:

TABLE 2-1
Herbicide Active Ingredients Proposed, Evaluated, and included in Current Environmental Impact Statements of the Bureau of Land Management

Active Ingredient	EIS in which Herbicide is Evaluated				Summary of Evaluations for all EISs		
	Northwest Area Noxious Weed Control Program (1985)	California Vegetation Management (1988)	Vegetation Treatment on BLM Lands in 13 Western States (1991)	Western Oregon Program – Management of Competing Vegetation (1992)	Active Ingredients Considered	Active Ingredients Evaluated	Active Ingredients Available for Use
2,4-D	Yes (Esteron-99; DMA-4)	Yes	Yes	Yes	Yes	Yes	Yes
2,4-DP		Yes			Yes	Yes	Yes
Ammonium sulfamate				Proposed, not evaluated	Yes	No	No
Amitrole		Yes	Evaluated, but not included		Yes	Yes	No
Asulam		Yes		Yes	Yes	Yes	Yes
Atrazine		Yes	Yes	Yes	Yes	Yes	Yes
Bromacil		Yes	Yes		Yes	Yes	Yes
Chlorsulfuron			Yes		Yes	Yes	Yes
Clopyralid			Yes		Yes	Yes	Yes
Dalapon		Yes	Evaluated, but not included	Proposed, but not evaluated	Yes	Yes	No
Dicamba	Yes (Banvel)	Yes	Yes	Yes	Yes	Yes	Yes
Diquat				Proposed, but not evaluated	Yes	No	No
Diuron		Yes	Yes	Proposed, but not evaluated	Yes	Yes	Yes
Fosamine		Yes		Proposed, but not evaluated	Yes	Yes	Yes
Glyphosate	Yes (Rodeo)	Yes	Yes	Yes	Yes	Yes	Yes
Hexazinone		Yes	Yes	Yes	Yes	Yes	Yes
Imazapyr			Yes		Yes	Yes	Yes
Mefluidide			Yes		Yes	Yes	Yes
Metsulfuron methyl			Yes		Yes	Yes	Yes
Monosodium methanearsonate				Proposed, but not evaluated	Yes	No	No
Picloram	Yes (Tordon 2K, Tordon 22K)	Yes	Yes	Yes	Yes	Yes	Yes
Simazine		Yes	Yes		Yes	Yes	Yes
Sulfometuron methyl			Yes		Yes	Yes	Yes
Tebuthiuron		Yes	Yes		Yes	Yes	Yes
Triclopyr		Yes	Yes	Yes	Yes	Yes	Yes
Active ingredients evaluated or available for use	4	16	17	8	25	22	20

TABLE 2-2
Herbicides Approved and Proposed for Use on Public Lands

Herbicide	Herbicide Characteristics and Target Vegetation	Areas Where Registered Use is Appropriate					
		Rangeland	Forestland	Riparian and Aquatic	Oil, Gas, and Minerals	ROW	Recreation and Cultural Resources
Herbicides Approved for Use on Public Lands							
2, 4-D	Selective; foliar absorbed; postemergent; annual/perennial broadleaf weeds. Key species treated include burningbush, mustard species, and Russian thistle.	•	•	•	•	•	•
2, 4-DP	Selective; foliar absorbed; postemergent; broadleaf weeds and woody species. Key species treated include burningbush, mustards, Russian thistle, and brush species.	•	•		•	•	•
Asulam	Inhibits mitosis; controls growing grasses and certain broadleaf weeds. Key species treated include brackenfern, dock, and Johnsongrass.				•	•	
Atrazine	Selective; mostly root absorbed; inhibits photosynthesis. Key species treated include annual grasses, mustards, pigweed, and Russian thistle.		•			•	
Bromacil	Non-selective; inhibits photosynthesis; controls wide range of weeds and brush. Key species treated include annual grasses and broadleaf weeds, burningbush, and Russian thistle.				•	•	•
Chlorsulfuron	Selective; inhibits enzyme activity; broadleaf weeds and grasses. Key species treated include biennial thistles and annual and perennial mustards.	•			•	•	•
Clopyralid	Selective; mimics plant hormones; annual and perennial broadleaf weeds. Key species treated include knapweeds, mesquite, and starthistle and other thistles.	•	•		•	•	•
Dicamba	Growth regulator; annual and perennial broadleaf weeds, brush, and trees. Key species treated include knapweeds, burningbush, and Russian thistle and other thistles.	•			•	•	•
Diuron	Preemergent control; annual and perennial broadleaf weeds and grasses. Key species treated include annual grasses and broadleaf weeds, burningbush, and Russian thistle.				•	•	•
Fosamine ammonium	Inhibits bud and leaf formation; broadleaf weeds, brush, and trees. Key species treated include field bindweed, leafy spurge, and locust.				•	•	•
Glyphosate	Non-selective; annual and perennial grasses and broadleaf weeds, sedges, shrubs, and trees. Key species treated include annual, biennial, and perennial grasses and broadleaf weeds and woody shrubs.	•	•	•	•	•	•
Hexazinone	Foliar or soil applied; inhibits photosynthesis; annual and perennial grasses and broadleaf weeds, brush, and trees. Key species treated include mesquite and scrub oak.	•	•		•	•	•
Imazapyr	Non-selective; preemergent and postemergent uses; absorbed through foliage and roots; annual and perennial broadleaf weeds, brush, and trees. Key species treated include saltcedar.	•	•	•	•	•	•
Mefluidide	Growth inhibitor; suppresses seed production of grasses, brush, and trees. Key species treated include roadside grasses.				•	•	•
Metsulfuron methyl	Selective; postemergent; inhibits cell division in roots and shoots; annual and perennial broadleaf weeds, brush, and trees. Key species treated include annual and perennial mustards and biennial thistles.	•	•		•	•	•
Picloram	Selective; foliar and root absorption; mimics plant hormones; certain annual and perennial broadleaf weeds, vines, and shrubs. Key species treated include knapweeds, leafy spurge, and starthistle.	•	•		•	•	•
Simazine	Used selectively or as complete vegetation killer; requires substantial moisture for activation; inhibits photosynthesis. Key species treated include annual grasses, mustards, pigweed, and Russian thistle.				•	•	•

TABLE 2-2 (Cont.)
Herbicides Approved and Proposed for Use on Public Lands

Herbicide	Herbicide Characteristics	Areas Where Registered Use is Appropriate					
		Rangeland	Forestland	Riparian and Aquatic	Oil, Gas, and Minerals	ROW	Recreation and Cultural Resources
Herbicides Approved for Use on Public Lands (Cont.)							
Sulfometuron methyl	Broad-spectrum pre and postemergent control; inhibits cell division; grasses and broadleaf weeds. Key species treated include downy brome, annual and perennial mustards, and medusahead.		•		•	•	•
Tebuthiuron	Relatively non-selective soil activated herbicide; pre and postemergent control of annual and perennial grasses, broadleaf weeds, and shrubs. Key species treated include creosote bush, oak, Russian olive, and sagebrush (thinning).	•			•	•	•
Triclopyr	Growth regulator; broadleaf weeds and woody plants. Key species treated include mesquite and saltcedar.	•	•	•	•	•	•
Herbicides Proposed for Use on Public Lands							
Diflufenzopyr + Dicamba	Postemergent; inhibits auxin transport; broadleaf weeds. Key species treated include knapweeds, burningbush, and Russian thistle and other thistles.	•			•	•	•
Diquat	Non-selective and foliar applied. Key species treated include giant salvinia, water-thyme, and watermilfoils.			•	▣	▣	▣
Fluridone	Aquatic herbicide to control submersed aquatic plants. Key species treated include water-thyme and watermilfoils.			•			
Imazapic	Selective postemergent herbicide; inhibits broadleaf weeds and some grasses. Key species treated include downy brome, leafy spurge, medusahead, and mustards.	•	•		•	•	•

• = Areas where USEPA approved registration exists and the BLM has approval or proposes to use on public lands; ▣ = Areas where USEPA approved registration exists, but where the BLM does not propose to use on public lands.

TABLE 2-3
States in which Herbicides are Approved for Use on Public Lands Based Upon Current Environmental Impact Statements, Court Injunctions, and Changes in Registration Status [1]

Chemical	AZ	CA	CO	ID	MT	NV	NM	ND	OK	OR E	OR W	SD	UT	WA	WY
2,4-D	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
2,4-DP		•													
Asulam		◉									o				
Atrazine	•	•	•	•	•	•	•	•	•	o	o	•	•	•	•
Bromacil	•	•	•	•	•	•	•	•	•	o		•	•	•	•
Chlorsulfuron	•		•	•	•	•	•	•	•	o		•	•	•	•
Clopyralid	•		•	•	•	•	•	•	•	o		•	•	•	•
Dicamba	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Diuron	•	•	•	•	•	•	•	•	•	o		•	•	•	•
Fosamine		•													
Glyphosate	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Hexazinone	•	•	•	•	•	•	•	•	•	o	o	•	•	•	•
Imazapyr	•		•	•	•	•	•	•	•	o		•	•	•	•
Mefluidide	•		•	•	•	•	•	•	•	o		•	•	•	•
Metsulfuron methyl	•		•	•	•	•	•	•	•	o		•	•	•	•
Picloram	•	◉	•	•	•	•	•	•	•	•	•	•	•	•	•
Simazine	•	•	•	•	•	•	•	•	•	o		•	•	•	•
Sulfometuron methyl	•		•	•	•	•	•	•	•	o		•	•	•	•
Tebuthiuron	•	•	•	•	•	•	•	•	•	o		•	•	•	•
Triclopyr	•	•	•	•	•	•	•	•	•	o	o	•	•	•	•

[1] These chemicals have not been approved for use in Alaska, Nebraska, and Texas.

• Based upon the current EISs, these herbicides have been analyzed and approved for application on BLM lands.

o Based upon the current EISs, these herbicides have been analyzed and approved for application on BLM lands, but are not currently approved for use in Oregon per court injunction (Southern Oregon Citizens Against Toxic Sprays (SOCATS) v. Watt, No. 79-1098 (District Court of Oregon. October 20, 1982), 13 Environmental Law Report 20, 176.

◉ Based upon the current EISs, these herbicides have been analyzed and approved for application on BLM lands, but application is not allowed due to change in registration status in the state.

- Incorporate measures to prevent introduction or spread of weeds into project layout, design, alternative evaluation, and project decisions.
- During environmental analysis for projects and maintenance programs, assess weed risks, analyze potential treatment of high-risk sites for weed establishment and spread, and identify prevention practices.
- Determine prevention and maintenance needs, to include the use of herbicides if needed, at the onset of project planning.
- Avoid or remove sources of weed seed and propagules to prevent new weed infestations and the spread of existing weeds.

During project development, weed infestations are prioritized for treatment in project operating areas and along access routes. Weeds present on or near the site are identified, a risk assessment is completed, and weeds are controlled as necessary. Project staging areas are weed free, and travel through weed infested areas is avoided or minimized. Examples of prevention actions to be followed during project activities include cleaning all equipment and clothing before entering the project site; avoiding soil disturbance and the creation of other soil conditions that promote weed germination and establishment; and using weed-free seed, hay, mulch,

gravel, soil, and mineral materials on public lands where there is a state or county program in place.

Conditions that enhance invasive species abundance should be addressed when developing mitigation and prevention plans for activities on public lands. These conditions include excessive disturbance associated with road maintenance, poor grazing management, and high levels of recreational use. If livestock grazing is managed to maintain the vigor of native perennial plants, particularly grasses, the chance of weeds invading rangeland is much less. By carefully managing recreational use and educating the public on the potential impacts of recreational activities on vegetation, the amount of damage to native vegetation and soil can be minimized at high use areas, such as campgrounds and OHV trails. Early detection in recreation areas is focused on roads and trails, where much of the weed spread occurs.

The BLM participates in the National Early Warning and Rapid Response System for Invasive Plants (Figure 2-1). The goal of this system is to minimize the establishment and spread of new invasive species through a coordinated framework of public and private processes:

- Early detection and reporting of suspected new plant species to appropriate officials;
- Identification and vouchering of submitted specimens by designated specialists;
- Verification of suspected new state, regional, and national plant specimens submitted by specialists;
- Archival of new records in designated regional and plant databases;
- Rapid assessment of confirmed new records; and
- Rapid response to verified new infestations that are determined to be invasive.

Revegetation

Disturbed areas may be reseeded or planted with desirable vegetation when the native plant community cannot recover and occupy the site sufficiently.

Determining the need for revegetation is an integral part of developing a vegetation treatment. The most important component of this process is determining whether active (seeding/planting) or passive (natural recovery) revegetation is appropriate.

USDI policy states, "Natural recovery by native plant species is preferable to planting or seeding, either of natives or non-natives. However, planting or seeding should be used only if necessary to prevent unacceptable erosion or resist competition from non-native invasive species" (620 Departmental Memorandum 3 2004). This policy is reiterated in the USDI *Burned Area Emergency Stabilization and Rehabilitation* Manual, the BLM *Draft Burned Area Emergency Stabilization and Rehabilitation Manual* (BLM H-1742-1; USDI BLM 2006a), and the *Interagency Burned Area Rehabilitation Guidebook* (USDI and USDA 2006d).

In addition to these handbooks and policy, use of native and non-native seed in revegetation and restoration is guided by BLM Manual 1745 (*Introduction, Transplant, Augmentation and Reestablishment of Fish, Wildlife and Plants)*. This manual states that native species shall be used, unless it is determined through the NEPA process that: 1) suitable native species are not available; 2) the natural biological diversity of the proposed management area will not be diminished; 3) exotic and naturalized species can be confined within the proposed management area; 4) analysis of ecological site inventory information indicates that a site will not support reestablishment of a species that historically was part of the natural environment; or 5) resource management objectives cannot be met with native species.

When natural recovery is not feasible, revegetation can be used to stabilize and restore vegetation on disturbed site and to eliminate or reduce the conditions that favor invasive species. Reseeding or replanting may be required when there is insufficient vegetation or seed stores to naturally revegetate the site.

To ensure revegetation success, there must be adequate soil for root development and moisture storage, which provides moisture to support the new plants. Chances for revegetation success are improved by selecting seed with high purity and percentage germination; selecting native species or cultivars adapted to the area; planting at proper depth, seeding rate, and time of the year for the region; choosing the appropriate planting method; and, where feasible, removing competing vegetation. Planting mixtures are adapted for the treatment area and site uses. A combination of forbs, perennial grasses, and shrubs is typically used on rangeland sites, while shrubs and trees might be favored for riparian and forestland sites. A mixture of several native plant species and types or functional groups enhances the value of the site for fish and wildlife and improves the health and aesthetic

character of the site. Mixtures can better take advantage of variable soil, terrain, and climatic conditions, and thus are more likely to withstand insect infestations and survive adverse climatic conditions.

The USDI BLM Native Seed program, which is in its sixth year, was developed in response to Congressional direction to supply native plant material for emergency stabilization and longer-term rehabilitation and restoration efforts. The focus of the program is to increase the number of native plant species for which seed is available and the total amount of native seed available for these efforts. To date, the program has focused on native plant material needs of emergency stabilization and burned area rehabilitation in the Great Basin, but is expanding to focus on areas such as western Oregon, the Colorado Plateau, and most recently the Mojave Desert. The Wildland Fire Management Program funds and manages the effort (USDI BLM 2006c).

The National Seed Warehouse is a storage facility for the native seed supply. Through a Memorandum of Understanding with the BLM Idaho State Director, each state (Idaho, Oregon, Nevada, Utah, and Colorado) can reserve an annual seed supply for purchase based on a reasonable projection of annual acreage to be stabilized or rehabilitated over a 5-year period.

The Great Basin Restoration Initiative (GBRI) grew out of concern for the health of the Great Basin after the wildfires of 1999. The goal of GBRI is to implement treatments and strategies to maintain functioning ecosystems and to proactively restore degraded ones at strategic locations. Native plants are emphasized in restoration projects where their use is practical and the potential for success is satisfactory. Monitoring is recommended to measure treatment success. To increase the availability of native plants, especially native forbs, the GBRI has established a collaborative native plant project, the Great Basin Native Plant Selection and Increase Project, to increase native plant availability and the technology to successfully establish these plants. This project is supported by funding from the BLM's Native Plant Initiative.

The BLM will follow the following SOPs when revegetating sites:

- Cultivate previously disturbed sites to reduce the amount of weed seeds in the soil seedbank.
- Revegetate sites once work is completed or soon after a disturbance.
- When available, use native seed of known origin as labeled by state seed certification programs.
- Use seed of non-native cultivars and species only when locally adapted native seed is not available or when it is unlikely to establish quickly enough to prevent soil erosion or weed establishment.
- Use seed that is free of noxious and invasive weeds, as determined and documented by a seed inspection test by a certified seed laboratory.
- Limit nitrogen fertilizer applications that favor annual grass growth over forb growth in newly seeded areas, especially where downy brome and other invasive annuals are establishing.
- Use clean equipment, free of plants and plant parts, on revegetation projects to prevent the inadvertent introduction of weeds into the site.
- Where important pollinator resources exist, include native nectar and pollen producing plants in the seed mixes used in restoration and reclamation projects. Include non-forage plant species in seed mixes for their pollinator/host relationships as foraging, nesting, or shelter species. Choose native plant species over manipulated cultivars, especially of forbs and shrubs, since natives tend to have more valuable pollen and nectar resources than cultivars. Ensure that bloom times for the flowers of the species chosen match the activity times for the pollinators. Maintain sufficient litter on the soil surfaces of native plant communities for ground-nesting bees.

Where feasible, avoid grazing by domestic and wild animals on treatment sites until vegetation is well established. Where total rest from grazing is not feasible, efforts should be made to modify the amount and/or season of grazing to promote vegetation recovery within the treatment area. Reductions in numbers, permanent or temporary fencing, changes in grazing rotation, and identification of alternative forage sources are examples of methods that could be used to remove, reduce or modify grazing impacts during vegetation recovery.

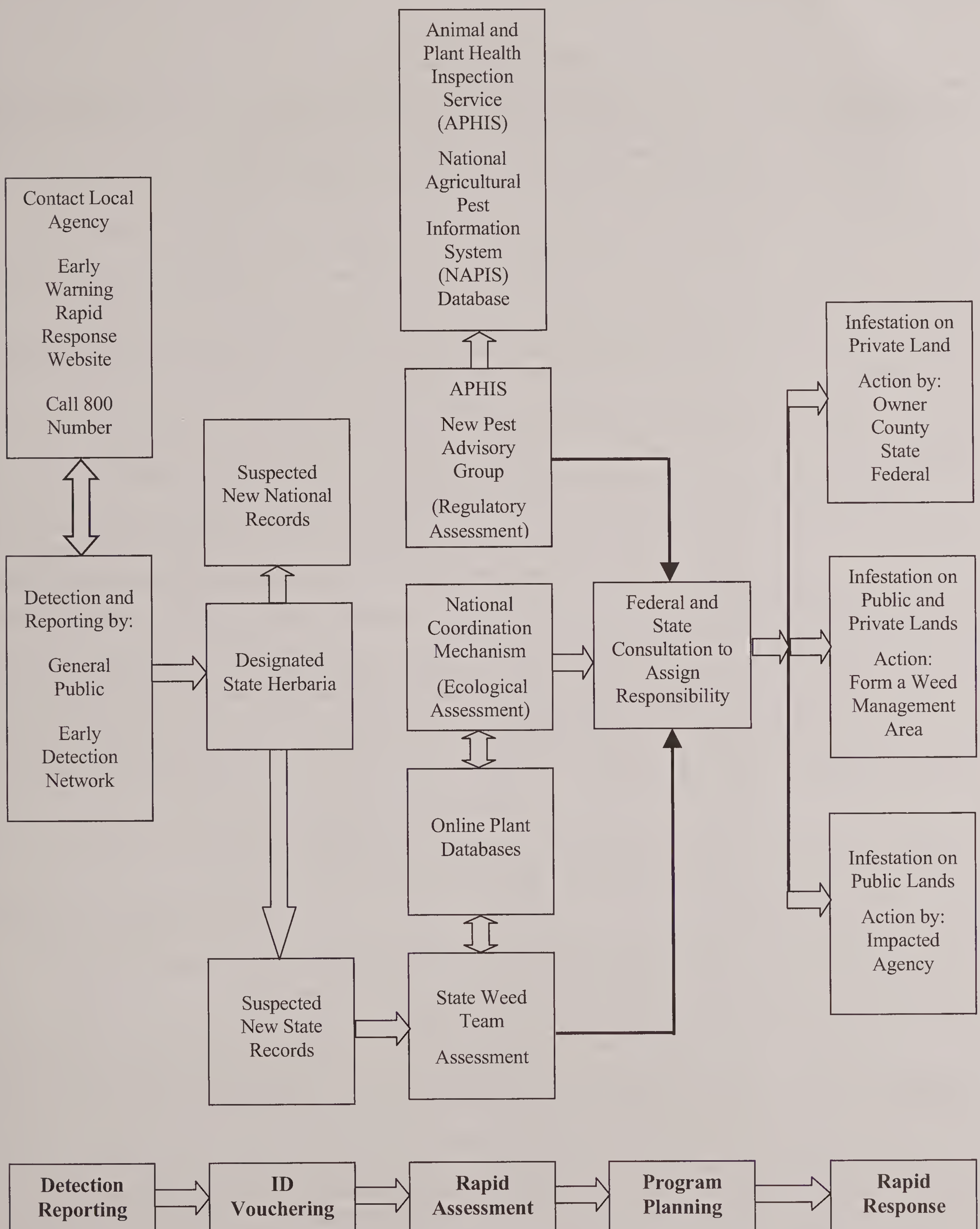

Figure 2-1. National Early Warning and Rapid Response System for Invasive Plants.

TABLE 2-4
Weed Prevention Measures

BLM Activity	PREVENTION MEASURE
Project Planning	• Incorporate prevention measures into project layout and design, alternative evaluation, and project decisions to prevent the introduction or spread of weeds. • Determine prevention and maintenance needs, including the use of herbicides, at the onset of project planning. • Before ground-disturbing activities begin, inventory weed infestations and prioritize areas for treatment in project operating areas and along access routes. • Remove sources of weed seed and propagules to prevent the spread of existing weeds and new weed infestations. • Pre-treat high-risk sites for weed establishment and spread before implementing projects. • Post weed awareness messages and prevention practices at strategic locations such as trailheads, roads, boat launches, and public land kiosks. • Coordinate project activities with nearby herbicide applications to maximize the cost-effectiveness of weed treatments.
Project Development	• Minimize soil disturbance to the extent practical, consistent with project objectives. • Avoid creating soil conditions that promote weed germination and establishment. • To prevent weed germination and establishment, retain native vegetation in and around project activity areas and keep soil disturbance to a minimum, consistent with project objectives. • Locate and use weed-free project staging areas. Avoid or minimize all types of travel through weed-infested areas, or restrict travel to periods when the spread of seeds or propagules is least likely. • Prevent the introduction and spread of weeds caused by moving weed-infested sand, gravel, borrow, and fill material. • Inspect material sources on site, and ensure that they are weed-free before use and transport. Treat weed-infested sources to eradicate weed seed and plant parts, and strip and stockpile contaminated material before any use of pit material. • Survey the area where material from treated weed-infested sources is used for at least 3 years after project completion to ensure that any weeds transported to the site are promptly detected and controlled. • Prevent weed establishment by not driving through weed-infested areas. • Inspect and document weed establishment at access roads, cleaning sites, and all disturbed areas; control infestations to prevent spread within the project area. • Avoid acquiring water for dust abatement where access to the water is through weed-infested sites. • Identify sites where equipment can be cleaned. Clean equipment before entering public lands. • Clean all equipment before leaving the project site if operating in areas infested with weeds. • Inspect and treat weeds that establish at equipment cleaning sites. • Ensure that rental equipment is free of weed seed. • Inspect, remove, and properly dispose of weed seed and plant parts found on workers' clothing and equipment. Proper disposal entails bagging the seeds and plant parts and incinerating them.
Revegetation	• Include weed prevention measures, including project inspection and documentation, in operation and reclamation plans. • Retain bonds until reclamation requirements, including weed treatments, are completed, based on inspection and documentation. • To prevent conditions favoring weed establishment, re-establish vegetation on bare ground caused by project disturbance as soon as possible using either natural recovery or artificial techniques. • Maintain stockpiled, uninfested material in a weed-free condition.

TABLE 2-4 (Cont.)
Prevention Measures

BLM Activity	Prevention Measure
Revegetation (Cont.)	• Revegetate disturbed soil (except travel ways on surfaced projects) in a manner that optimizes plant establishment for each specific project site. For each project, define what constitutes disturbed soil and objectives for plant cover revegetation. Revegetation may include topsoil replacement, planting, seeding, fertilization, liming, and weed-free mulching, as necessary. • Where practical, stockpile weed-seed-free topsoil and replace it on disturbed areas (e.g., road embankments or landings). • Inspect seed and straw mulch to be used for site rehabilitation (for wattles, straw bales, dams, etc.) and certify that they are free of weed seed and propagules. • Inspect and document all limited term ground-disturbing operations in noxious weed infested areas for at least 3 growing seasons following completion of the project. • Use native material where appropriate and feasible. Use certified weed-free or weed-seed-free hay or straw where certified materials are required and/or are reasonably available. • Provide briefings.that identify operational practices to reduce weed spread (for example, avoiding known weed infestation areas when locating fire lines). • Evaluate options, including closure, to regulate the flow of traffic on sites where desired vegetation needs to be established. Sites could include road and trail ROW, and other areas of disturbed soils.

Treatment-specific Standard Operating Procedures and Guidelines

Table 2-5 lists SOPs that have been identified to reduce adverse effects to environmental and human resources from vegetation treatment activities based on guidance in BLM manuals and handbooks, regulations, and standard agency and industry practices. The list is not all encompassing, but is designed to give an overview of practices that should be considered when designing and implementing a vegetation treatment project on public lands.

Special Precautions

Special Status Species

Federal policies and procedures for protecting federally-listed threatened and endangered plant and animal species, and species proposed for listing, were established by the Endangered Species Act of 1973 and regulations issued pursuant to the Act. The purposes of the Act are to provide mechanisms for the conservation of threatened and endangered species and their habitats. Under the Act, the Secretary of the Interior is required to determine which species are threatened or endangered and to issue recovery plans for those species.

Section 7 of the Act specifically requires all federal agencies to use their authorities in furtherance of the Act to carry out programs for the conservation of listed species, and to ensure that no agency action is likely to jeopardize the continued existence of a listed species or adversely modify critical habitat. Policy and guidance (BLM Manual 6840; *Special Status Species*) also stipulates that species proposed for listing must be managed at the same level of protection as listed species.

The BLM state directors may designate sensitive species in cooperation with their respective state. These sensitive species (special status) must receive, at a minimum, the same level of protection as federal candidate species. The BLM will also carry out management for the conservation of state-listed species, and state laws protecting these species will apply to all BLM programs and actions to the extent that they are consistent with FLPMA and other federal laws.

The BLM consulted with the USFWS and NMFS during development of the PEIS as required under Section 7 of the Endangered Species Act. As part of this process, the BLM prepared a formal consultation package that included a description of the program; species listed as threatened or endangered, species proposed for listing, and critical habitats that could be affected by the program; and a BA that evaluated the likely impacts to listed species, species proposed for listing, and critical habitats from the proposed

vegetation treatment program. Over 300 species were evaluated in the BA. The BA also provides broad guidance on a programmatic level for actions that would be taken by the BLM to avoid adversely impacting species or result in the destruction of critical habitat (USDI BLM 2007b).

Before any vegetation treatment or ground disturbance occurs, BLM policy requires a survey of the project site for species listed or proposed for listing, or special status species. This is done by a qualified biologist and/or botanist who consults the state and local databases and visits the site at the appropriate season. If a proposed project may affect a proposed or listed species or its critical habitat, the BLM consults with the USFWS and/or NMFS. A project with a "may affect, likely to adversely affect" determination requires formal consultation and receives a Biological Opinion from the USFWS and/or NMFS. A project with a "may affect, not likely to adversely affect" determination requires informal consultation and receives a concurrence letter from USFWS and/or NMFS, unless that action is implemented under the authorities of the alternative consultation agreement pursuant to counterpart regulations established for *National Fire Plan* projects.

Wilderness Areas

Wilderness areas, which are designated by Congress, are defined by the Wilderness Act of 1964 as places "where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." The BLM manages 175 Wilderness Areas encompassing over 7.2 million acres (USDI BLM 2006d).

Activities allowed in wilderness areas are identified in wilderness management plans prepared by the BLM. The BLM does not ordinarily treat vegetation in wilderness areas, but will control invasive and noxious weeds when they threaten lands outside wilderness area or are spreading within the wilderness and can be controlled without serious adverse impacts to wilderness values.

Management of vegetation in a wilderness area is directed toward retaining the natural character of the environment. Tree and shrub removal is usually not allowed, except for fire, insect, or disease control. Reforestation is generally prohibited except to repair damage caused by humans in areas where natural reforestation is unlikely. Only native species and primitive methods, such as hand planting, are allowed for reforestation.

Tools and equipment may be used for vegetation management when they are the minimum amount necessary for the protection of the wilderness resource. Motorized tools may only be used in special or emergency cases involving the health and safety of wilderness visitors, or the protection of wilderness values.

Habitat manipulation using mechanical or chemical means may be allowed to protect threatened and endangered species and to correct unnatural conditions, such as weed infestations, resulting from human influence.

The BLM also manages a total of 610 Wilderness Study Areas (WSAs) encompassing nearly 14.3 million acres. These are areas that have been determined to have wilderness characteristics worthy of consideration for wilderness designation. The BLM's primary goals in WSAs are to manage them so as to not impair their wilderness values and to maintain their suitability for preservation as wilderness until Congress makes a determination on their future.

In WSAs, the BLM must foster a natural distribution of native species of plants and animals by ensuring that ecosystems and processes continue to function naturally.

Cultural Resources

The effects of BLM actions on cultural resources are addressed through compliance with the National Historic Preservation Act, as implemented through a national Programmatic Agreement (*Programmatic Agreement among the Bureau of Land Management, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers Regarding the Manner in Which BLM Will Meet Its Responsibilities Under the National Historic Preservation Act*) and state-specific protocol agreements with SHPOs. The BLM's responsibilities under these authorities are addressed as early in the vegetation management project planning process as possible.

The BLM meets its responsibilities for consultation and government-to-government relationships with Native American tribes by consulting with appropriate tribal representatives prior to making decisions that affect tribal interests. The BLM's tribal consultation policies

TABLE 2-5
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
Guidance Documents	BLM handbooks H-9211-1 (*Fire Management Activity Planning Procedures*) and H-9214-1 (*Prescribed Fire Management*), and manuals 1112 (*Safety*), 9210 (*Fire Management*), 9211 (*Fire Planning*), 9214 (*Prescribed Fire*), and 9215 (*Fire Training and Qualifications*).	BLM Handbook H-5000-1 (*Public Domain Forest Management*), and manuals 1112 (*Safety*) and 9015 (*Integrated Weed Management*).	BLM *Domain Forest Management*, and manuals 1112 (*Safety*), and 9015 (*Integrated Weed Management*).	BLM manuals 1112 (*Safety*), 4100 (*Grazing Administration*), 9014 (*Use of Biological Control Agents on Public Lands*), and 9015 (*Integrated Weed Management)* and Handbook H-4400-1 (*Rangeland Health Standards*).	BLM Handbook H-9011-1 (*Chemical Pest Control*), and manuals 1112 (*Safety*), 9011 (*Chemical Pest Control*), 9015 (*Integrated Weed Management)*, and 9220 (*Integrated Pest Management*).
General	• Prepare fire management plan. • Use trained personnel with adequate equipment. • Minimize frequent burning in arid environments. • Avoid burning herbicide-treated vegetation for at least 6 months.	• Ensure that power cutting tools have approved spark arresters. • Ensure that crews have proper fire-suppression tools during the fire season. • Wash vehicles and equipment before leaving weed infested areas to avoid infecting weed-free areas. • Keep equipment in good operating condition.	• Ensure that crews have proper fire-suppression tools during fire season. • Minimize soil disturbance, which may encourage new weeds to develop.	• Use only biological control agents that have been tested and approved to ensure they are host specific. • If using domestic animals, select sites with weeds that are palatable and non-toxic to the animals. • Manage the intensity and duration of containment by domestic animals to minimize overutilization of desirable plant species. • Utilize domestic animals to contain the target species in the treatment areas prior to weed seed set. Or if seed set has occurred, do not move the domestic animals to uninfested areas for a period of 7 days.	• Prepare a spill contingency plan in advance of treatment. • Select herbicides that are least dangerous to the environment while providing the desired results. • Minimize the size of treatment areas, where feasible. • Use the least amount of herbicide necessary to achieve the desired result. • Follow product label for use and storage. • Have a licensed applicator apply herbicides. • Keep records of each application, including the active ingredient, formulation, application rate, date, time, and location. • Dispose of unwanted herbicides promptly and correctly.

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
Land Use	• Carefully plan fires in the WUI to avoid or minimize loss of structures and property. • Notify nearby residents and landowners who could be affected by smoke intrusions or other fire effects.	• Collaborate on project development with nearby landowners and agencies.	• Collaborate on project development with nearby landowners and agencies.	• Notify nearby residents and landowners who could be affected by biological control agents.	• Consider surrounding land uses before aerial spraying. • Comply with herbicide-free buffer zones to ensure that drift will not affect crops or nearby residents and landowners. • Post treated areas and specify reentry times, if appropriate.
Air Quality See Manual 7000 (*Soil, Water, and Air Management*).	• Have clear smoke management objectives. • Evaluate weather conditions, including wind speed and atmospheric stability, to predict effects of burn and impacts from smoke. • Burn when weather conditions favor rapid combustion and dispersion. • Burn under favorable moisture conditions. • Use backfires, when applicable. • Burn small vegetation blocks, when appropriate. • Manage smoke to prevent air quality violations and minimize impacts to smoke-sensitive areas. • Coordinate with air pollution and fire control officials, and obtain all applicable smoke management permits, to ensure that burn plans comply with federal, state, and local	• Maintain equipment in optimal working order. • Conduct treatment activities during the wetter seasons. • Use heavy equipment under adequate soil moisture conditions to minimize soil erosion. • Minimize vehicle speeds on unpaved roads. • Minimize dust impacts to the extent practicable.	• Maintain equipment in optimal working order. • Conduct treatment activities during the wetter seasons. • Minimize vehicle speeds on unpaved roads. • Minimize dust impacts to the extent practicable.		• Consider effects of wind, humidity, temperature inversions, and heavy rainfall on herbicide effectiveness and risks. • Apply herbicides in favorable weather conditions to minimize drift. For example, do not treat when winds exceed 10 mph (6 mph for aerial applications) or rainfall is imminent. • Apply herbicides consistent with label directions. • Use drift reduction agents, as appropriate, to reduce the drift hazard. • Select proper application equipment (e.g., equipment that produces 200- to 800-micron diameter droplets). • Select proper application methods and use appropriate buffer distances between spray sites and non-target resources.

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
	regulations.				
Soil Resources See Manual 7000 (*Soil, Water, and Air Management*).	• Assess the susceptibility of the treatment site to soil damage and erosion prior to treatment. • Prescribe broadcast and other burns that are consistent with soil management activities. • Plan burns so as to minimize damage to soil resources. • Conduct burns when moisture content of large fuels, surface organic matter, and soil is high to limit the amount of heat penetration into lower soil surfaces and protect surface organic matter. • Time treatments to encourage rapid recovery of vegetation. • Further facilitate revegetation by seeding or planting following treatment. • When appropriate, reseed following burning to re-introduce species, or to convert a site to a less flammable plant association, rather than to specifically minimize erosion.	• Assess the susceptibility of the treatment site to soil damage and erosion prior to treatment. • Time treatments to avoid intense rainstorms. • Time treatments to encourage rapid recovery of vegetation. • Further facilitate revegetation by seeding or planting following treatment. • Use equipment that minimizes soil disturbance and compaction. • Minimize use of heavy equipment on slopes >20%. • Conduct treatments when the ground is sufficiently dry to support heavy equipment. • Implement erosion control measures in areas where heavy equipment use occurs. • Minimize disturbances to biological soil crusts (e.g., by timing treatments when crusts are moist). • Reinoculate biological crust organisms to aid in their recovery, if possible. • Conduct mechanical treatments along topographic contours to minimize runoff and	• Assess the susceptibility of the treatment site to soil damage and erosion prior to treatment. • Time treatments to avoid intense rainstorms. • Time treatments to encourage rapid recovery of vegetation. • Further facilitate revegetation by seeding or planting following treatment. • Minimize soil disturbance and compaction. • Minimize disturbance to biological soil crusts (e.g., by timing treatments when crusts are moist). • Reinoculate biological crust organisms to aid in their recovery, if possible. • When appropriate, leave plant debris on site to retain moisture, supply nutrients, and reduce erosion. • Prevent oil and gas spills to minimize damage to soil.	• Assess the susceptibility of the treatment site to soil damage and erosion prior to treatment. • Minimize use of domestic animals if removal of vegetation may cause significant soil erosion or impact biological soil crusts. • Closely monitor timing and intensity of biological control with domestic animals. • Avoid grazing on wet soil to minimize compaction and shearing.	• Assess the susceptibility of the treatment site to soil damage and erosion prior to treatment. • Minimize treating areas where herbicide runoff is likely, such as steep slopes when heavy rainfall is expected. • Minimize the use of herbicides that have high soil mobility, particularly in areas where soil properties increase the potential for mobility. • Time treatments to encourage rapid recovery of desirable vegetation. • Further facilitate revegetation by seeding or planting following treatment.

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	Mechanical	Manual	Biological	Chemical
Soil Resources (cont.)		erosion. • When appropriate, leave plant debris on site to retain moisture, supply nutrients, and reduce erosion. • Consider chaining when soils are frozen and plants are brittle to minimize soil disturbance.			
Water Resources See Manual 7000 (*Soil, Water, and Air Management*).	• Prescribe burns that are consistent with water management objectives. • Plan burns to minimize negative impacts to water resources. • Minimize burning on hillslopes, or revegetate hillslopes shortly after burning. • Maintain a vegetated buffer between treatment areas and water bodies.	• Minimize removal of desirable vegetation near residential and domestic water sources. • Do not wash equipment or vehicles in water bodies. • Maintain minimum 25-foot wide vegetated buffer near streams and wetlands.	• Maintain vegetated buffer near residential and domestic water sources. • Minimize removal of desirable vegetation near residential and domestic water sources. • Minimize removal of desirable vegetation near water bodies.	• Minimize use of domestic animals near residential or domestic water sources. • Minimize use of domestic animals adjacent to water bodies if trampling or other activities are likely to cause soil erosion or impact water quality.	• Consider climate, soil type, slope, and vegetation type when developing herbicide treatment programs. • Do not rinse spray tanks in or near water bodies. • Do not broadcast herbicide pellets where there is danger of contaminating water supplies. • Minimize treating areas with a high risk for groundwater contamination. • Maintain buffers between the treatment area and water bodies. Buffer widths should be developed based on herbicide- and site-specific criteria to minimize impacts to water bodies.
Wetlands and Riparian Areas	• Following treatment, reseed or replant with native vegetation if the native plant community cannot recover and occupy the site	• Manage riparian areas to provide adequate shade, sediment control, bank stability, and recruitment of wood into stream channels.	• Following treatment, reseed or replant with native vegetation if the native plant community cannot recover and occupy the site	• Manage animals to prevent overgrazing and minimize damage to wetlands. • Following treatment, reseed or replant with	• Use appropriate herbicide-free buffer zone for herbicides not labeled for aquatic use based on risk assessment guidance, with minimum widths of

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	Mechanical	Manual	Biological	Chemical
Wetlands and Riparian Areas (cont.)	sufficiently.	• Following treatment, reseed or replant with native vegetation if the native plant community cannot recover and occupy the site sufficiently.	sufficiently.	native vegetation if the native plant community cannot recover and occupy the site sufficiently.	100 feet for aerial, 25 feet for vehicle, and 10 feet for hand spray applications. • Following treatment, reseed or replant with native vegetation if the native plant community cannot recover and occupy the site sufficiently.
Vegetation See Handbook H-4410-1 (*National Range Handbook*), and manuals 5000 (*Forest Management*) and 9015 (*Integrated Weed Management*).	• Keep fires as small as possible to meet the treatment objectives. • Conduct low intensity burns to minimize adverse impacts to large vegetation. • Limit area cleared for fire breaks and clearings to reduce potential for weed infestations. • Where appropriate, use mechanical treatments to prepare forests for the reintroduction of fire. • Identify and implement any temporary domestic livestock grazing and/or supplemental feeding restrictions needed to enhance desirable vegetation recovery following treatment. • Consider adjustments in the existing grazing permit, including the application of state or regional grazing administration guidelines, needed to maintain	• Power wash vehicles and equipment to prevent the introduction and spread of weed and exotic species. • Remove damaged trees and treat woody residue to limit subsequent mortality by bark beetles. • Use plant stock or seed from the same seed zone and from sites of similar elevation when conducting revegetation activities. • Use lighter chains with 40 to 60 pound links where the objective is to minimize disturbance to the understory species. • As appropriate, use two chainings to reduce tree competition and prepare the seedbed. Carry out the second chaining at the most advantageous time for seeding (late fall or early winter, in most cases). • Do not chain in areas	• Remove damaged trees and treat woody residue to limit subsequent mortality by bark beetles. • Identify and implement any temporary domestic livestock grazing and/or supplemental feeding restrictions needed to enhance desirable vegetation recovery following treatment. • Consider adjustments in the existing grazing permit, including the application of state or regional grazing administration guidelines, needed to maintain desirable vegetation on the treatment site. • Use plant stock or seed from the same seed zone and from sites of similar elevation when conducting revegetation activities.	• Use domestic animals at the time they are most likely to damage invasive species. • Manage animals to prevent overgrazing and minimize damage to sensitive areas. • Identify and implement any temporary domestic livestock grazing and/or supplemental feeding restrictions needed to enhance desirable vegetation recovery following treatment. • Consider adjustments in the existing grazing permit, including the application of state or regional grazing administration guidelines, needed to maintain desirable vegetation on the treatment site. • Use plant stock or seed from the same seed zone and from sites of similar elevation when	• Use drift reduction agents, as appropriate, to reduce the drift hazard to non-target species. • Use the appropriate application rate to treat weeds and other noxious vegetation to minimize effects to non-target vegetation. • Conduct pre-treatment surveys for sensitive habitat and species of concern within and adjacent to proposed treatment areas. • Identify and implement any temporary domestic livestock grazing and/or supplemental feeding restrictions needed to enhance desirable vegetation recovery following treatment. • Consider adjustments in the existing grazing permit, including the application of state or regional grazing policies and administration

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
Vegetation (cont.)	desirable vegetation on the treatment site. • Use plant stock or seed from the same seed zone and from sites of similar elevation when conducting revegetation activities.	where annual rainfall is less than 6-9 inches, especially if downy brome is present. • Identify and implement any temporary domestic livestock grazing and/or supplemental feeding restrictions needed to enhance desirable vegetation recovery following treatment. • Consider adjustments in the existing grazing permit, including the application of state or regional grazing administration guidelines, needed to maintain desirable vegetation on the treatment site.		conducting revegetation activities.	guidelines, needed to maintain desirable vegetation on the treatment site. • Use plant stock or seed from the same seed zone and from sites of similar elevation when conducting revegetation activities.
Fish and Other Aquatic Resources See Manual 6500 (*Wildlife and Fisheries Management*).	• Maintain vegetated buffers near fish-bearing streams to minimize soil erosion and soil runoff into streams. • Minimize treatments near fish-bearing streams during periods when fish are in sensitive life stages (e.g., embryo).	• Minimize treatments adjacent to fish-bearing waters. • Do not wash vehicles in streams or wetlands. • Refuel and service equipment at least 100 feet from water bodies to reduce the chance for pollutants to enter water. • Maintain adequate vegetated buffer between treatment area and water body to reduce the potential for sediments and other pollutants to enter the water body.	• Refuel and service equipment at least 100 feet from water bodies to reduce the chance for pollutants to enter water. • Minimize removal of desirable vegetation near fish-bearing streams and wetlands.	• Limit access of domestic animals to streams and other water bodies to minimize sediments entering water and potential for damage to fish habitat.	• Use appropriate buffer zones based on label and risk assessment guidance. • Minimize treatments near fish-bearing streams during periods when fish are in life stages most sensitive to the herbicide(s) used. • Use spot, rather than aerial treatments, near water bodies. • Use herbicides that are least toxic to fish and still effective.
Wildlife Resources	• Minimize treatments during nesting and other important periods for	• Minimize treatments during nesting and other important periods for	• Minimize treatments during nesting and other important periods for	• Minimize the use of livestock grazing as a vegetation control	• Minimize treatments during nesting and other important periods for

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
Wildlife Resources (cont.) See Manual 6500 (*Wildlife and Fisheries Management)*	birds and other wildlife. • Minimize treatments of important forage areas immediately prior to important use period(s), unless the burn is designed to stimulate forage growth.	birds and other wildlife. • Retain wildlife trees and other unique habitat features where practical. • Design chaining treatments to provide a mosaic of treated and nontreated sites. No more than 50% of an area should be chained at one time. Provide natural travel lanes, resting and thermal cover areas, snags, and corridors (>30 feet wide) connecting non-chained areas. Size of clearing should not exceed 100 yards at its widest point.	birds and other wildlife. • Retain wildlife trees and other unique habitat features where practical.	measure where and/or when it could impact nesting and/or other important periods for birds and other wildlife. • Consider and minimize potential adverse impacts to wildlife habitat and minimize the use of livestock grazing as a vegetation control measure where it is likely to result in removal or physical damage to vegetation that provides a critical source of food or cover for wildlife.	wildlife. • Use herbicides of low toxicity to wildlife, where feasible. • Conduct pre-treatment surveys for sensitive habitat and wildlife species of concern. • Avoid using glyphosate formulations that include R-11 in the future, and either avoid using any formulations with POEA, or seek to use the formulation with the lowest amount of POEA available, to reduce risks to amphibians. • Minimize use of herbicides near wetlands and riparian areas with amphibians.
Threatened and Endangered Species See Manual 6840 (*Special Status Species*) and *Vegetation Treatments Using Herbicides on BLM Lands in 17 Western States Programmatic Biological Assessment.*	• Survey for special status species of concern if project may impact federally- and state-listed species. • Minimize direct impacts to species of concern, unless studies show that species will benefit from fire.	• Minimize use of ground-disturbing equipment near special status species of concern. • Survey for species of concern if project could impact these species. • Use temporary roads when long-term access is not required.	• Survey for special status species of concern if project could impact these species.	• Survey for special status species of concern if project could impact these species.	• Survey for special status species before treating an area.
Livestock See Handbook H-4120-1 (*Grazing Management*).	• Notify permittees of proposed treatments and identify any needed livestock grazing, feeding, or slaughter restrictions.	• Notify permittees of proposed treatments and identify any needed livestock grazing, feeding, or slaughter restrictions.	• Notify permittees of proposed treatments and identify any needed livestock grazing, feeding, or slaughter restrictions.	• Notify permittees of proposed treatments and identify any needed livestock grazing, feeding, or slaughter restrictions.	• Notify permittees of proposed treatments and identify any needed livestock grazing, feeding, or slaughter restrictions.

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
Livestock (cont.)	• Design treatments to take advantage of normal livestock grazing rest periods, when possible, and minimize impacts to livestock grazing permits. • Provide alternative forage sites for livestock, if possible. • Notify permittees of the project to improve coordination and avoid potential conflicts and safety concerns during implementation of the treatment.	• Design treatments to take advantage of normal livestock grazing rest periods, when possible, and minimize impacts to livestock grazing permits. • Provide alternative forage sites for livestock, if possible. • Notify permittees of the project to improve coordination and avoid potential conflicts and safety concerns during implementation of the treatment.	• Design treatments to take advantage of normal livestock grazing rest periods, when possible, and minimize impacts to livestock grazing permits. • Provide alternative forage sites for livestock, if possible. • Notify permittees of the project to improve coordination and avoid potential conflicts and safety concerns during implementation of the treatment.	• Design treatments to take advantage of normal livestock grazing rest periods, when possible, and minimize impacts to livestock grazing permits. • Provide alternative forage sites for livestock, if possible. • Notify permittees of the project to improve coordination and avoid potential conflicts and safety concerns during implementation of the treatment.	• Design treatments to take advantage of normal livestock grazing rest periods, when possible, and minimize impacts to livestock grazing permits. • Provide alternative forage sites for livestock, if possible. • Use herbicides of low toxicity to livestock, where feasible. • As directed by the herbicide label, remove livestock from treatment sites prior to herbicide application, where applicable. • Take into account the different types of application equipment and methods, where possible, to reduce the probability of contamination of non-target food and water sources. • Notify permittees of the project to improve coordination and avoid potential conflicts and safety concerns during implementation of the treatment.
Wild Horses and Burros	• Minimize potential hazards to horses and burros by ensuring adequate escape opportunities. • Avoid critical periods and minimize impacts to	• Avoid critical periods and minimize impacts to habitat that could adversely affect wild horse or burro populations.	• Avoid critical periods and minimize impacts to habitat that could adversely affect wild horse or burro populations.	• Avoid critical periods and minimize impacts to habitat that could adversely affect wild horse or burro populations.	• Minimize use of herbicides in project areas actively grazed by wild horses and burros, and/or use herbicides with low toxicity to reduce potential impacts.

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
Wild Horses and Burros (cont.)	critical habitat that could adversely affect wild horse or burro populations.				• Remove wild horses and burros from identified treatment areas prior to herbicide application, in accordance with label directions for livestock. • Take into account the different types of application equipment and methods, where possible, to limit the probability of contaminating non-target food and water sources. • Avoid critical periods and minimize impacts to habitat that could adversely affect wild horse or burro populations.
Paleontological and Cultural Resources See handbooks H-8120-1 (*Guidelines for Conducting Tribal Consultation*) and H-8270-1 (*General Procedural Guidance for Paleontological Resource Management*), and manuals 8100 (*The Foundations for Managing Cultural Resources*), 8120 (*Tribal Consultation Under Cultural Resource Authorities*), and 8270 (*Paleontological Resource*	• Follow standard procedures for compliance with Section 106 of the National Historic Preservation Act as implemented through the National Programmatic Agreement and state protocols or 36 CFR Part 800, including necessary consultations with the State Historic Preservation Officers and affected tribes. • Follow BLM Handbook H-8270-1 to determine known Condition 1 and Condition 2 paleontological areas, or collect information through inventory to	• Follow standard procedures for compliance with Section 106 of the National Historic Preservation Act as implemented through the National Programmatic Agreement and state protocols or 36 CFR Part 800, including necessary consultations with the State Historic Preservation Officers and interested tribes. • Follow BLM Handbook H-8270-1 to determine known Condition 1 and Condition 2 paleontological areas, or collect information through inventory to	• Follow standard procedures for compliance with Section 106 of the National Historic Preservation Act as implemented through the National Programmatic Agreement and state protocols or 36 CFR Part 800, including necessary consultations with the State Historic Preservation Officers and interested tribes. • Follow BLM Handbook H-8270-1 to determine known Condition 1 and Condition 2 paleontological areas, or collect information through inventory to	• Follow standard procedures for compliance with Section 106 of the National Historic Preservation Act as implemented through the National Programmatic Agreement and state protocols or 36 CFR Part 800, including necessary consultations with the State Historic Preservation Officers and interested tribes. • Follow BLM Handbook H-8270-1 to determine known Condition 1 and Condition 2 paleontological areas, or collect information through inventory to	• Follow standard procedures for compliance with Section 106 of the National Historic Preservation Act as implemented through the National Programmatic Agreement and state protocols or 36 CFR Part 800, including necessary consultations with the State Historic Preservation Officers and interested tribes. • Follow BLM Handbook H-8270-1 to determine known Condition 1 and Condition 2 paleontological areas, or collect information through inventory to

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
Management). See also: *Programmatic Agreement among the Bureau of Land Management, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers Regarding the Manner in Which BLM Will Meet Its Responsibilities Under the National Historic Preservation Act (1997).*	establish Condition 1 and Condition 2 areas, determine resource types at risk from the proposed treatment, and develop appropriate measures to minimize or mitigate adverse impacts. • Identify cultural resource types at risk from fire use and design inventories that are sufficient to locate these resources. Provide measures to minimize impacts. • Identify opportunities to meet tribal cultural use plant objectives for projects on public lands. • Monitor significant paleontological and cultural resources for potential looting of materials where they have been exposed by fire.	establish Condition 1 and Condition 2 areas, determine resource types at risk from the proposed treatment, and develop appropriate measures to minimize or mitigate adverse impacts. • Identify cultural resource types at risk from mechanical treatments and design inventories that are sufficient to locate these resources. Provide measures to minimize impacts. • Identify opportunities to meet tribal cultural use plant objectives for projects on public lands. • Consult with tribes to locate any areas of vegetation that are of significance to the tribe and that might be affected, adversely or beneficially, by mechanical treatments.	establish Condition 1 and Condition 2 areas, determine resource types at risk from the proposed treatment, and develop appropriate measures to minimize or mitigate adverse impacts. • Identify cultural resource types at risk from manual treatments and design inventories that are sufficient to locate these resources. Provide measures to minimize impacts. • Identify opportunities to meet tribal cultural use plant objectives for projects on public lands. • Consult with tribes to locate any areas of vegetation that are of significance to the tribe and that might be affected, adversely or beneficially, by manual treatments.	establish Condition 1 and Condition 2 areas, determine resource types at risk from the proposed treatment, and develop appropriate measures to minimize or mitigate adverse impacts. • Identify opportunities to meet tribal cultural use plant objectives for projects on public lands. • Consult with tribes to locate any areas of vegetation that are of significance to the tribe and that might be affected, adversely or beneficially, by biological treatments.	establish Condition 1 and Condition 2 areas, determine resource types at risk from the proposed treatment, and develop appropriate measures to minimize or mitigate adverse impacts. • Identify opportunities to meet tribal cultural use plant objectives for projects on public lands. • Consult with tribes to locate any areas of vegetation that are of significance to the tribe and that might be affected, adversely or beneficially, by herbicide treatments.
Visual Resources See handbooks H-8410-1 (*Visual Resource Inventory*) and H-8431-1 (*Visual Resource Contrast Rating*), and Manual 8400 (*Visual Resource Management*).	• Minimize use of fire in sensitive watersheds to reduce the creation of large areas of browned vegetation. • Consider the surrounding land use before assigning fire as a treatment method. • At areas such as visual overlooks, leave sufficient vegetation in place, where possible, to	• Minimize dust drift, especially near recreational or other public use areas. • Minimize loss of desirable vegetation near high public use areas. • At areas such as visual overlooks, leave sufficient vegetation in place, where possible, to screen views of vegetation treatments.	• Minimize dust drift, especially near recreational or other public use areas. • Minimize loss of desirable vegetation near high public use areas. • At areas such as visual overlooks, leave sufficient vegetation in place, where possible, to screen views of vegetation treatments.	• At areas such as visual overlooks, leave sufficient vegetation in place, where possible, to screen views of vegetation treatments. • Lessen visual effects in Class I and Class II visual resource areas. • Design activities to repeat the form, line, color, and texture of the natural landscape character	• At areas such as visual overlooks, leave sufficient vegetation in place, where possible, to screen views of vegetation treatments. • Minimize use of broadcast foliar applications in sensitive watersheds to avoid creating large areas of browned vegetation. • Consider the surrounding

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	Mechanical	Manual	Biological	Chemical
Visual Resources (cont.)	screen views of vegetation treatments. • Avoid use of fire near agricultural or densely populated areas, where feasible. • Lessen visual effects in Class I and Class II visual resource areas. • Design activities to repeat the form, line, color, texture of the natural landscape conditions to meet established Visual Resource Management (VRM) objectives.	• Minimize earthwork and locate away from prominent topographic features. • Revegetate treated sites. • Lessen visual effects in Class I and Class II visual resource areas. • Design activities to repeat the form, line, color, and texture of the natural landscape character conditions to meet established VRM objectives.	• Lessen visual effects in Class I and Class II visual resource areas. • Design activities to repeat the form, line, color, and texture of the natural landscape character conditions to meet established VRM objectives.	conditions to meet established VRM objectives.	land use before assigning aerial spraying as an application method. • Avoid aerial spraying near agricultural or densely populated areas, where feasible. • Minimize off-site drift and mobility of herbicides (e.g., do not treat when winds exceed 10 mph; avoid treating areas where herbicide runoff is likely; establish appropriate buffer widths between treatment areas and residences). • Lessen visual effects in Class I and Class II visual resource areas. • When restoring treated areas, design activities to repeat the form, line, color, and texture of the natural landscape character conditions to meet established VRM objectives.
Wilderness and Other Special Areas See handbooks H-8550-1 (*Management of Wilderness Study Areas (WSAs)*), and H-8560-1 (*Management of Designated Wilderness Study Areas*), and Manual	• Minimize soil-disturbing activities during fire control or prescribed fire activities. • Revegetate sites with native species if there is no reasonable expectation of natural regeneration. • Maintain adequate buffers for Wild and Scenic Rivers.	• Use the least intrusive methods possible to achieve objectives, and use non-motorized equipment in wilderness and off existing routes in wilderness study areas, and where possible in other areas. • If mechanized equipment is required, use the minimum amount of equipment needed.	• Use the least intrusive methods possible to achieve objectives, and use non-motorized equipment in wilderness and off existing routes in wilderness study areas, and where possible in other areas. • Revegetate sites with native species if there is no reasonable expectation of natural regeneration.	• Use the least intrusive methods possible to achieve objectives, and use non-motorized equipment in wilderness and off existing routes in wilderness study areas, and where possible in other areas. • Maintain adequate buffers for Wild and Scenic Rivers.	• Revegetate disturbed sites with native species if there is no reasonable expectation of natural regeneration. • Use chemicals only when they are the minimum method necessary to control weeds that are spreading within the wilderness or threaten lands adjacent to the wilderness.

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
8351 (*Wild and Scenic Rivers*).		• Time the work for weekdays or off-season. • Require shut down of work before evening if work is located near campsites. • If aircraft are used, plan flight paths to minimize impacts on visitors and wildlife. • Revegetate sites with native species if there is no reasonable expectation of natural regeneration. • Maintain adequate buffers for Wild and Scenic Rivers.	• Maintain adequate buffers for Wild and Scenic Rivers.		• Give preference to herbicides that have the least effect on non-target species and the wilderness environment. • Implement herbicide treatments during periods of low human use, where feasible. • Maintain adequate buffers for Wild and Scenic Rivers.
Recreation See Handbook H-1601-1 (*Land Use Planning Handbook*).	• Control public access to potential burn areas. • Schedule treatments to avoid peak recreational use times, unless treatments must be timed during peak times to maximize effectiveness. • Notify the public of treatment methods, hazards, times, and nearby alternative recreation areas.	• Control public access until potential treatment hazards no longer exist. • Schedule treatments to avoid peak recreational use times, unless treatments must be timed during peak times to maximize effectiveness. • Notify the public of treatment methods, hazards, times, and nearby alternative recreation areas.	• Control public access until potential treatment hazards no longer exist. • Schedule treatments to avoid peak recreational use times, unless treatments must be timed during peak times to maximize effectiveness. • Notify the public of treatment methods, hazards, times, and nearby alternative recreation areas.	• Control public access in areas with control agents to ensure that agents are effective. • Schedule treatments to avoid peak recreational use times, unless treatments must be timed during peak times to maximize effectiveness. • Notify the public of treatment methods, hazards, times, and nearby alternative recreation areas.	• Adhere to entry restrictions identified on the herbicide label for public and worker access. • Post signs noting exclusion areas and their duration. • Schedule treatments to avoid peak recreational use times, unless treatments must be timed during peak times to maximize effectiveness. • Notify the public of treatment methods, hazards, times, and nearby alternative recreation areas.
Social and Economic Values	• Post treatment areas. • Notify adjacent landowners, grazing permittees, the public, and emergency personnel of treatments.	• Post treatment areas. • Notify adjacent landowners, grazing permittees, the public, and emergency personnel of treatments.	• Post treatment areas. • Notify adjacent landowners, grazing permittees, the public, and emergency personnel of treatments.	• Post treatment areas. • Notify adjacent landowners, grazing permittees, the public, and emergency personnel of treatments.	• Observe restricted entry intervals given on herbicide labels. • Post treated areas and specify reentry or rest times, if appropriate.

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	**Mechanical**	**Manual**	**Biological**	**Chemical**
Social and Economic Values (cont.)	• Control public access to treatment areas. • Consult with Native American tribes and Alaska Natives whose health and economies might be affected by the project. • To the extent feasible, hire local contractors and purchase supplies locally.	• Control public access to treatment areas. • Consult with Native American tribes and Alaska Natives whose health and economies might be affected by the project. • To the extent feasible, hire local contractors and purchase supplies locally.	• Control public access to treatment areas. • Consult with Native American tribes and Alaska Natives whose health and economies might be affected by the project. • To the extent feasible, hire local contractors and purchase supplies locally.	• Control public access to treatment areas. • Consult with Native American tribes and Alaska Natives whose health and economies might be affected by the project. • To the extent feasible, hire local contractors and purchase supplies locally.	• Notify adjacent landowners, grazing permittees, the public, and emergency personnel of treatments. • Control public access until potential treatment hazards no longer exist. • Consult with Native American tribes and Alaska Natives whose health and economies might be affected by the project. • To the degree possible within the law, hire local contractors and purchase supplies locally.
Rights-of-way	• Coordinate vegetation management activities where joint or multiple use of a ROW exists. • Notify other public land users within or adjacent to the ROW proposed for treatment. • Manage burns under powerlines so as to avoid negative impacts to the powerline.	• Coordinate vegetation management activities where joint or multiple use of a ROW exists. • Notify other public land users within or adjacent to the ROW proposed for treatment. • Apply appropriate safety measures when operating equipment within utility ROW corridors. • Minimize exposed soil areas during treatment. • Keep operations within prescribed ROW.	• Coordinate vegetation management activities where joint or multiple use of a ROW exists. • Notify other public land users within or adjacent to the ROW proposed for treatment. • Always use appropriate safety equipment and operating procedures. • Utilize methods for disposal of vegetation that prevent spreading or reinfestation of unwanted vegetation.	• Coordinate vegetation management activities where joint or multiple use of a ROW exists. • Notify other public land users within or adjacent to the ROW proposed for treatment.	• Coordinate vegetation management activities where joint or multiple use of a ROW exists. • Notify other public land users within or adjacent to the ROW proposed for treatment. • Use only herbicides that are approved for use in ROW areas. • Take precautions to minimize drift by not applying herbicides when winds exceed > 10 mph (6 mph for aerial applications) or a serious rainfall event is imminent. • Use drift control agents and low volatile formulations.

TABLE 2-5 (Cont.)
Vegetation Treatment Methods Standard Operating Procedures and Guidelines

Resource Element	Treatment Method				
	Fire Use	Mechanical	Manual	Biological	Chemical
Human Health and Safety	• Use some form of pretreatment, such as mechanical or manual treatment, in areas where fire cannot be safely introduced because of hazardous fuel buildup. • Wear appropriate safety equipment and clothing, and use equipment that is properly maintained. • Notify nearby residents who could be affected by smoke. • Maintain adequate safety buffers between treatment area and residences/structures. • Burn vegetation debris off ROWs to ensure that smoke does not provide a conductive path from the transmission line or electrical equipment to the ground.	• Wear appropriate safety equipment and clothing, and use equipment that is properly maintained. • Cut all brush and tree stumps flat, where possible, to eliminate sharp points that could injure a worker or the public. • Ensure that only qualified personnel cut trees near powerlines.	• Wear appropriate safety equipment and clothing, and use equipment that is properly maintained. • Cut all brush and tree stumps flat, where possible, to eliminate sharp points that could injure a worker or the public.	• Wear appropriate safety equipment and clothing, and use equipment that is properly maintained.	• Use protective equipment as directed by the herbicide label. • Maintain adequate buffer widths between treatment area and residences, municipal water supplies, and recreation areas. • Post treated areas with appropriate signs at common public access areas. • Provide public notification in newspapers or other media where the potential exists for public exposure. • Have a copy of Material Safety Data Sheets at work sites. • Notify local emergency personnel of proposed treatments. • Contain and clean up spills and request help as needed. • Secure containers during transport.

are detailed in BLM Manual 8120 (*Tribal Consultation Under Cultural Resource Authorities)* and Handbook H-8120-1 (*Guidelines for Conducting Tribal Consultation).* The BLM consulted with Native American tribes and Alaska Native groups during development of the PEIS. Information gathered on important tribal resources and potential impacts to these resources from herbicide treatments is presented in the analysis of impacts.

When conducting vegetation treatments, field office personnel consult with relevant parties (including tribes, native groups, and SHPOs), assess the potential of the proposed treatment to affect cultural and subsistence resources, and devise inventory and protection strategies suitable to the types of resources present and the potential impacts to them.

Herbicide treatments, for example, are unlikely to affect buried cultural resources, but might have a negative effect on traditional cultural properties comprised of plant foods or materials significant to local tribes and native groups. These treatments require inventory and protection strategies that reflect the different potential of each treatment to affect various types of cultural resources.

Impacts to significant cultural resources are avoided through project redesign or are mitigated through data recovery, recordation, monitoring, or other appropriate measures. When cultural resources are discovered during vegetation treatment, appropriate actions are taken to protect these resources.

Monitoring

Monitoring ensures that vegetation management is an adaptive process that continually builds upon past successes and learns from past mistakes. The regulations of 43 CFR 1610.4-9 require that land use plans establish intervals and standards for monitoring and evaluation of land management actions. During preparation of implementation plans, treatment objectives, standards, and guidelines are stated in measurable terms, where feasible, so that treatment outcomes can be measured, and evaluated, and used to guide future treatment actions. This approach ensures that vegetation treatment processes are effective, adaptive, and based on prior experience.

The diversity of plant communities on BLM lands calls for a diversity of monitoring approaches. Monitoring strategies may vary in time and space depending on the species. Sampling designs and techniques vary depending on the type of vegetation. Guidance on monitoring methodologies can be found in such BLM documents as *Measuring and Monitoring Plant Populations* (BLM Technical Reference 1730-1), which was developed in cooperation with The Nature Conservancy. Other guidance documents include *Sampling Vegetation Attributes* (Interagency Technical Reference 4400-4), developed in cooperation with the Forest Service, the Natural Resource Conservation Service, and the Cooperative Extension Service; and the *Ecological Site Inventory* (BLM Inventory and Monitoring Technical Reference 1734-7). These documents, as well as numerous other guidance documents for specific plant communities, can be found on the National Science and Technology Center website (http://www.blm.gov/nstc). These documents, plus any regionally specific documents developed to meet management objectives allow for the flexibility needed to monitor the variety of vegetation on public lands.

Two types of monitoring of vegetation treatments may be pursued by the BLM. One type is implementation monitoring which answers the question, "Did we do what we said we would do?" The second type is effectiveness monitoring, which answers the question, "Were treatment and restoration projects effective?" Implementation monitoring is usually done at the land use planning level or through annual work plan accomplishment reporting. Effectiveness monitoring is usually done at the local project implementation level.

Invasive plant implementation monitoring for non-herbicide treatments is accomplished through site revisits performed during the growing season of the target species to determine if treatments were implemented correctly and the best time for follow-up treatments.

For herbicide use, implementation monitoring is accomplished through the use of Pesticide Use Proposals (PUPs) and Pesticide Application Records. Both documents are required by the BLM in order to track pesticide use annually. The PUP requires reporting of the pesticide proposed for use and the maximum application rate. It also requires reporting of the number and timing of applications. Targeted species and non-targeted species at the treatment site are described, as well as the other site characteristics. A description of sensitive resources and mitigation measures to protect these resources is also required. Most importantly, the integrated weed management approach to be taken (i.e., the combination of treatments to be used) is required. The NEPA document that analyzes the effects of the

treatment must also be referenced. PUPs must be signed by a certified weed applicator, the field office manager, state coordinator, and deputy state director before the treatment can go forward. The Pesticide Application Record, which must be completed within 24 hours after completion of the application, documents the actual rate of application and that all the above factors have been taken into account. Pesticide Application Records are used to develop annual state summaries of herbicide use for BLM.

PUPs and Pesticide Application Records can also be used for more site-specific implementation monitoring. For example, the Application Record can be used to track whether the application was made at the correct time, if mitigation for sensitive wildlife concerns is included in the PUP.

Monitoring of invasive plant treatment effectiveness can range from site visits to compare the targeted population size against pre-treatment inventory data, to comparing pre-treatment and post-treatment photo points, to more elaborate transect work, depending on the species and site-specific variables. The goals of monitoring should be to answer questions such as the following:

- What changes in the distribution, amount, and proportion of invasive plant infestations have resulted due to treatments?
- Has infestation size been reduced at the project level or larger scale (such as a watershed)?
- Which treatment methods, separate or in combination, are most successful for a particular species? (USDA Forest Service 2005).

Monitoring data can have far-reaching applications in fire management because it provides the scientific basis for planning and implementing future burn treatments. Measuring post-fire ecosystem response allows the BLM to understand the consequences of fire on important ecosystem components and to share this knowledge in a scientifically based language. Monitoring is the critical feedback loop that allows fire management to constantly improve prescriptions and fire plans based on the new knowledge gained from field measurements. FIREMON is an interagency monitoring program that is used for monitoring fuels treatment effectiveness. When a fuels treatment project involves an invasive species (such as tamarisk or Russian olive), monitoring can be done using a program such as FIREMON.

Another monitoring protocol frequently used to inventory and monitor forest vegetation is called the Forest Vegetation Information System or FORVIS. FORVIS is a system for storage, retrieval, and analysis of data about forestlands. These data describe existing vegetation, classify sites relative to current condition, can be use in forest growth and structure and wildlife habitat models, describe landscapes, aid in developing forest restoration treatments, and provide a record of treatment and disturbance events.

BLM monitoring activities also include the BLM Legacy program, which is an outgrowth of the need to provide current BLM field managers and specialists with an opportunity to learn about past land management practices and land treatments, and to evaluate the results of those practices 25 or more years later (USDI BLM 2002a). The Legacy program is intended to bring together current land managers and specialists with retired and active employees who performed the land treatments in the past. The underlying philosophy of the program is that if BLM land managers do not learn from the past, they cannot know which treatments are effective and which are not.

The *Healthy Forests Restoration Act of 2003* instructs the BLM to establish a collaborative multiparty monitoring, evaluation, and accountability process when significant interest is expressed in such an approach. The process is used to assess the positive and negative ecological and social effects of projects carried out under Healthy Forests Restoration Act authority. Multiparty monitoring can be an effective way to build trust and collaboration with local communities and diverse stakeholders, including interested citizens and tribes.

The results of monitoring should be made available to interested parties. A website with links to geospatial and other data sets will ensure that inventory data, and treatment methods and results, are shared easily. The BLM has a website, http://www.blm.gov, with links to BLM programs, such as the weed program, and other data sources, including geospatial data. Most state offices are tied into state data clearinghouses that contain useful information gathered by federal, state, and local agencies.

Monitoring Guidance used by BLM in Vegetation Management

The BLM has prepared numerous guidance and strategy documents to aid field personnel in developing and

implementing monitoring plans and strategies. These include the following:

- ***BLM National Monitoring Strategy (2006).*** The BLM is currently developing a national strategy to manage the collection, storage, and use of data describing the interrelationship of resource conditions, resource uses, and the BLM's own activities. The goals of the strategy are to: 1) enhance the efficiency and effectiveness of the BLM's assessment, inventory, and monitoring efforts; 2) establish and use a limited number of resource indicators that are common to most or all BLM field offices, and that are comparable or identical to measures used by other government agencies and non-governmental organizations; and 3) standardize data collection, evaluation, and reporting in a way that improves the quality of the BLM's land use planning and other management decisions, and enhances the BLM's ability to manage for multiple uses.

- ***BLM Land Use Planning Handbook H-1601-1 (2005)***. Establishes requirements for periodic implementation and effectiveness monitoring for land use planning decisions.

- ***Monitoring Manual for Grasslands, Shrubland, and Savanna Ecosystems Vols. I and II. USDA Agricultural Research Service (2005).*** Provides quantitative methods to address indicators of rangeland health.

- ***BLM Technical Reference 1730-2 Biological Soil Crusts (2001).*** Provides technical guidance on how to develop and implement effective monitoring plans for biological soil crusts.

- ***BLM Handbook H-4180-1 Rangeland Health Standards (2001).*** Provides technical guidance on evaluating rangeland health, developing plans to improve rangeland health, and monitoring the progress of rangeland health plans.

- ***BLM Technical Reference 1730-1 Measuring and Monitoring Plant Populations (1998).*** Provides technical guidance on how to develop and implement effective monitoring plans for vegetation and use monitoring in adaptive management.

- ***BLM Technical Reference 1734-4 Sampling Vegetative Attributes (1996).*** Provides the basis for consistent, uniform, and standard vegetation attribute sampling that is economical, repeatable, statistically reliable, and technically adequate.

- ***Manual Section 9011 Chemical Pest Control (1992)***. Establishes requirements for monitoring pesticide applications.

- ***Manual Section 9014 Use of Biological Control Agents of Pests on Public Lands (1990).*** Establishes requirements to monitor success or failure in survival, control, and spread of biological agents.

- ***Guidelines for Coordinated Management of Noxious Weeds (1990).*** Provides guidance on establishing monitoring plans for noxious weeds and their control.

- ***BLM Handbook H-4400 Rangeland, Inventory, Monitoring, and Evaluation (1989).*** Provides technical guidance on how to measure vegetation uses such as livestock grazing, wild horse and burro use, and wildlife browsing and foraging.

- ***BLM Handbook H-9011-1 Chemical Pest Control (1988).*** Provides technical guidance on post-treatment evaluations for pesticide applications to occur within 2 years of treatment.

- ***NEPA Handbook H-1790-1 Chapter VI – Monitoring (1988).*** All actions and mitigation measures, including monitoring and enforcement programs, adopted in a decision document are legally enforceable commitments. The purposes of monitoring in a NEPA context are to 1) ensure compliance with decisions, 2) measure effectiveness of decisions, and 3) evaluate validity of decisions.

- ***Manual Section 1734 Monitoring and Inventory Coordination (1983).*** Provides the BLM with technical guidance on how to develop and implement effective monitoring plans for vegetation.

Numerous other technical references for inventory, monitoring, and assessment are found at: http://www.blm.gov/nstc/library/techref.htm. In

addition, state-specific handbooks to guide monitoring based on the national level guidance (e.g., *Nevada Monitoring Handbook, Oregon Monitoring Handbook*).

Monitoring Methods and Research

Fuels treatment and noxious weed control projects must begin with an understanding of which techniques and monitoring methods are most effective, as determined through careful research and follow-up monitoring. The BLM has been supporting research at universities and Forest Service research stations through the Joint Fire Science program and projects such as the Great Basin Restoration Initiative. The Joint Fire Science program has supported research on such topics as fire effects, effects from fuels treatments, and the use of fire as a tool in controlling invasive plants (http://www.firescience.gov/). Under the Great Basin Restoration Initiative, ongoing projects involving weed control, restoration, and fire treatments help provide a link between science and management to ensure that ecologically-based restoration is implemented. These projects are at: http://www.blm.gov/nifc/st/en/prog/fire/snapshots/html.

Dissemination of research and monitoring results and information occurs in a variety of ways, including formal conferences and workshops of fire management professionals, the National Science and Technology Center, publications such as Resource Notes, and BLM state websites. Snapshots, an online publication found at http://www.fire.blm.gov/snapshots.htm, highlights BLM projects that support the *National Fire Plan*. Examples of successful projects and community collaborations that have been discussed in Snapshots include creation and monitoring of fuels breaks, habitat improvement through prescribed burning, fuels reduction and associated monitoring, and the progress of a downy brome taskforce. Examples of project successes include the following:

- In Wyoming, a multi-agency prescribed burn was completed in 2005 to reduce hazardous fuels and improve the health and vigor of native plant communities. Monitoring methods include permanent vegetation transects and photo points to provide post-burn results and an elk collaring study to show which treatment areas are being used by elk. The information obtained during this study will be shared with the public, and the site will be used by school classes.
- In Wyoming, a tamarisk reduction project was started in the Bighorn Basin in 2000 to restore native cottonwood galleries. The project involves various combinations of treatments, as well as plantings of native species following the treatments.
- In Washington, the BLM has been treating reed canarygrass since 2003, using a combination of prescribed burning, herbicides, and mowing, followed by seedbed preparation and reseeding with native seed mixtures. This project is a partnership with the Natural Resource Conservation Service, Washington State Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service.

BLM offices maintain monitoring reports to document that fuels treatments meet set objectives. Monitoring plans typically include plots and photo points, at which pre- and post-treatment data are collected. This type of monitoring has successfully provided data that has allowed the BLM to confirm that project goals have been met.

Coordination and Education

As demonstrated at public scoping meetings for the PEIS, the public is deeply interested in BLM vegetation treatment activities, especially individuals that live in close proximity to public lands, have commercial operations dependant on vegetation on or adjacent to public lands, or use public lands for recreation. The BLM strives to keep the public informed about its vegetation treatment activities through regular coordination and communication. The BLM also encourages the public to participate in the environmental review process during the development and analysis of local vegetation management programs.

Several laws and Executive Orders set forth public involvement requirements, including involving the public in the environmental analysis, land use planning, and implementation decision-making processes to address local, regional, and national interests (USDI BLM 2000f).

The BLM is ultimately responsible for land use plan decisions, including decisions about vegetation management, on public lands. The BLM has found, however, that collaborative relationships with stakeholders, including individuals, communities, and governments, improves communication, provides a

greater understanding of different perspectives, and helps to find solutions to issues and problems. Input from the public and government agencies has been critical during development of the PEIS and PER.

The NEPA process ensures that the public is allowed input into vegetation management actions on public lands. For treatment projects requiring an EA or EIS, the BLM must notify the public of the proposed project and give the public the opportunity to comment on the site-specific analysis done for the project. Treatment actions may be modified in response to comments posed by the public. The public may also be invited to observe treatment activities and participate in project monitoring.

Public lands are often commingled with private lands, or lands under the jurisdiction of tribal, state, or local governments or other federal agencies. Multijurisdictional planning assists land use planning efforts when there is a mix of land ownership and government authorities, and there are opportunities to develop complementary decisions across jurisdictional boundaries.

Examples of these types of planning efforts include development of weed treatment programs involving the BLM and nearby private landowners, or coordination with parties who hold land use authorizations including ROW, leases, permits, or easements. Many BLM weed coordinators hold classes for public land users to make them aware of the problem and to solicit their help in reporting new weed infestations.

Because vegetation treatments have a direct effect on the productivity and use of grazing allotments, coordination and consultation with the grazing permittee(s), and any other interested parties affected by a vegetation treatment, would be necessary.

It is critical that the BLM notify potentially affected parties of treatment activities that occur on public lands. This can be done through a letter, phone call, meeting, newsletter, newspaper article, or other medium to ensure that potentially affected parties can comment on the proposed action and take any steps needed to protect life and property from proposed actions.

Prior to herbicide treatments, the BLM posts entry points onto public lands where the herbicide application will take place. Information provided in the posting includes herbicide product applied; active ingredients; USEPA registration number; application date; period of time which must elapse before a person without protective clothing may enter a treatment site; and other warnings or information required to ensure the safety of the public.

The BLM enjoys wide participation in various national, state, and local prevention and education efforts pertaining to noxious and invasive species and hazardous fuels management. The BLM participates in state FireWise programs, state Fire Safe Councils, the National Wildfire Coordinating Group Wildland Fire Education Working Team, and the National Wildland Fire Prevention and Education Team. Local education efforts such as Project: FIRE bring BLM natural resource professionals to schools to educate students about fire prevention and safety. Noxious weed and invasive species education programs span the K-12 grades and are led by many local BLM field office ecologists and natural resource professionals. The BLM also participates in Project Learning Tree. Project Learning Tree, one of the most widely-used environmental education programs in the country, provides education curricula for fire and invasive species education.

CHAPTER 3

PUBLIC LAND RESOURCES

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CHAPTER 3

PUBLIC LAND RESOURCES

Introduction and Study Area

This chapter describes the natural and socioeconomic environment of public lands in the western U.S., including Alaska, which would be affected by the alternatives under consideration. It focuses on the resources that were identified in Chapter 1, and is useful in understanding the environmental, cultural, and social consequences of the proposed program.

Land Use and Ecoregions

Land Use

The BLM manages nearly 261 million acres in the western U.S. and Alaska. Public lands represent from less than 0.1% of the total land area in some western states to over 67% of lands in Nevada (Table 3-1).

Approximately 164 million acres of public lands are upland rangeland, of which approximately 161 million acres are open to livestock grazing. Other public uses on rangeland include recreation, and oil, gas, and mineral development.

Another 55 million acres are forestland and woodland. Forestlands and woodlands are a source of timber and other forest products, and are used for livestock grazing, recreational, and cultural purposes.

Wetland and riparian areas total about 23 million acres and are primarily used for recreation and grazing. The remaining 19 million acres consist of barren mountains, mountaintops, glaciers, sand dunes, and playas. These areas are primarily used for recreation.

Ecoregions

Because this PER addresses a broad geographic region with a diverse range of biophysical characteristics, it is useful to subdivide this region into smaller, homogeneous areas for analysis. Where possible, information on resources has been organized by ecoregions rather than by state boundaries. Ecoregions are geographic areas that are delineated and defined by similar climatic conditions, geomorphology, and soils (Bailey 1997, 2002). Since these factors are relatively constant over time and strongly influence the ecology of vegetative communities, ecoregions may have similar potentials and responses to disturbance (Clarke and Bryce 1997; Jensen et al. 1997). Ecoregions, therefore, provide a useful framework for organizing, interpreting, and predicting changes to vegetation following management treatments.

TABLE 3-1
Acres of Public Lands in 17 Western States and Percent of Lands in the State Administered by the BLM

State	Acres of BLM Land	Percent of State Lands Administered by the BLM
Alaska	85,468,616	23.5
Arizona	12,218,180	16.8
California	15,230,638	15.1
Colorado	8,363,916	12.6
Idaho	12,001,817	22.5
Montana	7,963,511	8.5
Nebraska	6,354	<0.1
Nevada	47,824,624	67.6
New Mexico	13,371,737	17.2
North Dakota	58,837	0.1
Oklahoma	2,136	<0.1
Oregon	16,135,761	26.0
South Dakota	274,437	0.6
Texas	11,833	<0.1
Utah	22,858,179	42.1
Washington	408,580	0.9
Wyoming	18,366,584	29.3
Total	260,565,740	23.5

Source: USDI BLM (2006c, d). Acreages are approximate and subject to change in response to land transfers.

The public lands addressed in this PER lie within eight major physiographic regions, or ecoregion divisions: Tundra, Subarctic, Subtropical Steppe, Subtropical Desert, Temperate Steppe, Temperate Desert, Mediterranean, and Marine, including Mountain Provinces (Map 3-1).

Climate

Climate is the statistical distribution of atmospheric conditions, as determined by the weather patterns that result from long-term fluctuations in global atmospheric and hydrologic cycles. Climatic patterns describe the annual distribution of energy and moisture, thus affecting the amount and seasonal distribution of temperature, precipitation, and winds. These factors influence the composition and distribution of rangeland vegetation, as well as the formation and erosion of rangeland soils, and hydrological conditions. These factors also influence the distribution of wind-borne air pollutants, such as smoke from wildfires and prescribed fires.

The western U.S. experiences several broad climatic groups: polar, boreal, temperate, Mediterranean highland, and dry. Polar and boreal climates dominate in Alaska, while a humid temperate climate is characteristic of the coastal areas of Washington, Oregon, and northern California. The southern California coast has a Mediterranean climate, while mountainous areas have a highland climate. The rest of the western states east of the Cascade, Sierra Nevada, and Rocky mountains are characterized by a dry climate. On a regional scale, temperature and precipitation vary with latitude, elevation, distance from the oceans, and the position of mountain ranges with respect to prevailing winds. The eight ecoregions found in the treatment area are based on the seasonality of precipitation, and on the degree of dryness or cold, and depend largely on latitude and continental position.

Tundra Ecoregion

The climate of the westernmost and northernmost portion of Alaska (including the Alaska Peninsula and Aleutian Islands), is typified by cold Arctic air masses. The tundra climate has a very short, cool summer and a long, severe winter, with the warmest average monthly temperature between 50 °F and 32 °F (freezing). Between 55 and 188 days per year typically have a daily mean temperature above freezing. Annual precipitation is often less than 8 inches, but the climate is humid because of the low potential evaporation.

Subarctic Ecoregion

The moist, boreal climate type demonstrates a large seasonal temperature range. Winters dominate, with cool, short summers. Because average monthly temperatures are below freezing for up to 7 consecutive months, soil moisture freezes solidly to depths up to 14 feet. Only a single month has an average temperature above 50 °F. The limited precipitation (10 to 20 inches annually) falls mainly during the short summer months, although thunderstorms are uncommon.

Subtropical Steppe Ecoregion

The western subtropical steppe borders deserts on both the north and south, with the temperate steppe to the north and east. This ecoregion division has a hot semiarid climate where potential evaporation exceeds precipitation, and where all months have average temperatures above freezing. Bright sunny days with cool clear nights are typical. Precipitation ranges from 10 to 20 inches per year, with a summertime peak due to thunderstorm activity.

Subtropical Desert Ecoregion

South and west of the Arizona-New Mexico Mountains is the subtropical desert climate. This region is not only very dry, but also has extreme maximum summer temperatures. In addition, both daytime solar and nocturnal radiation are high, leading to extreme daily temperature variations. Annual precipitation is less than 8 inches.

Temperate Steppe Ecoregion

Temperate steppes are areas with a semiarid continental climatic regime, where evaporation usually exceeds precipitation. Seven or less months have an average temperature above 50 °F. Winters are cold and dry, and summers are warm to hot, with at least 1 month's average temperature below freezing.

Temperate Desert Ecoregion

Temperate deserts are generally dry with wide temperature differences between summer and winter. In the intermountain region between the Pacific coast and Rocky Mountains, the temperate desert has a very pronounced drought season and a short humid season. Most precipitation falls in winter, despite a small peak in late spring. Eight or more months have an average temperature above 50 °F. Winter is relatively short, but with at least 1 month's average temperature below freezing.

Mediterranean Ecoregion

Most of California west of the Sierra Nevada Mountains and Mojave Desert is typified by alternate wet winters and dry summers, within a strong transition zone between the dry desert and the wet coast. Mild temperatures dominate, with the coldest average monthly temperature between 65 °F and 27 °F. Most precipitation occurs in winter, with the wettest month receiving nearly 3 times the precipitation of the driest summer month.

Marine Ecoregion

The temperate oceanic climate extends from southeast Alaska down the Pacific Coast to southwestern Oregon. This climate receives abundant rainfall from maritime air masses, with average temperatures moderated by the ocean. Although the warmest average monthly temperature is below 72 °F for at least 4 months, the average temperature is above 50 °F; the coldest month averages just above 32 °F. Annual precipitation is high (40 to 80 inches per year), but significantly lower in summer. The relatively low temperatures reduce evaporation, producing a very damp, humid climate with substantial cloud cover. Mild winters and cool summers are typical.

Mountain Provinces

The mountainous portions of all eight ecoregion divisions exhibit a highland climate, where site-specific conditions vary greatly, depending on altitude and exposure. Windward slopes typically have greater precipitation (and leeward slopes less precipitation) than the ecoregion division as a whole. Southern exposures also tend to be warmer than slopes with northern exposures. Finally, the occurrence of mountain winds (up slope during the day, down slope at night) and diurnal temperature inversions is greatest near mountains.

Air Quality

Because air pollution can directly pose health risks and cause significant welfare impacts to humans, improvement of air quality in the U.S. is an important regulatory goal. The Clean Air Act (originally passed in 1955 and amended several times since), establishes a mandate to reduce emissions of specific pollutants via uniform federal standards. Under the Act, the USEPA is responsible for setting standards and approving state implementation plans (SIPs) to ensure that local agencies comply with the Act.

The standards set by the USEPA include primary and secondary NAAQS for six pollutants, referred to as criteria pollutants, to protect public health and welfare. The criteria pollutants are sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead (Pb), and particulate matter (PM).

Particulate matter is a generic term for a broad class of chemically and physically diverse substances that exist as discrete particles over a wide range of sizes. For regulatory purposes, PM is sub-classified by the particle's aerodynamic diameter. PM_{10} includes all PM with an aerodynamic diameter of 10 microns or less and is referred to as inhalable PM. $PM_{2.5}$ includes all PM with an aerodynamic diameter of 2.5 microns or less, called fine PM, and is by definition a subset of PM_{10}. Studies have shown more serious health effects associated with $PM_{2.5}$; therefore, the USEPA promulgated more stringent standards for this class of PM.

The NAAQS are listed in Table 3-2. The primary NAAQS protect the health of sensitive individuals, and the secondary NAAQS protect the general welfare of the public. Different averaging periods are established for the criteria pollutants based on their potential health and welfare effects. The NAAQS are enforced by states, which in some cases have adopted additional or more stringent standards.

All areas of the nation have been classified based on their status with regard to attaining the NAAQS. An area is designated by the USEPA as being in attainment for a criteria pollutant if ambient concentrations of that pollutant are below the NAAQS, or being in nonattainment if criteria pollutant concentrations violate the NAAQS. Once nonattainment areas comply with the NAAQS, they are designated as maintenance areas. Areas that are classified as nonattainment must implement a plan to reduce ambient concentrations below the NAAQS. Areas where insufficient data are available to determine attainment status are designated as unclassified, and are treated as attainment areas for regulatory purposes.

The Clean Air Act also provides for the prevention of significant deterioration (PSD) of air quality, especially in areas of the country where the air quality is much better than standards. In Class I areas, only a

TABLE 3-2
National Ambient Air Quality Impact Significance Criteria (μg/m^3)

Pollutant	Averaging Period[1]	NAAQS		PSD Increments[2]	
		Primary	Secondary	Class I	Class II
NO_2	Annual	100	100	2.5	25
CO	1-hour	40,000	NA	NA	NA
	8-hour	10,000	NA	NA	NA
PM_{10}	24-hour	150	150	8	30
	Annual	NA	NA	4	17
$PM_{2.5}$	24-hour	35	35	NA	NA
	Annual	15	15	NA	NA
SO_2	3-hour	NA	1,300	25	512
	24-hour	365	NA	5	91
	Annual	80	NA	2	20
Lead	Quarter	1.5	1.5	NA	NA
O_3	1-hour[3]	235	235	NA	NA
	8-hour[3]	157	157	NA	NA

[1] Annual standards are never to be exceeded. Short-term standards (those other than annual or quarterly) are not to be exceeded more than once per year, except for O_3, PM_{10}, and $PM_{2.5}$ standards. For O_3, the expected number of days with ozone levels above the standard is not to be exceeded more than once per calendar year. For PM_{10}, the standard is attained when the 99th percentile concentration for the year is less than the standard. For $PM_{2.5}$, the standard is attained when the 98th percentile concentration for the year is less than the standard.
[2] Prevention of significant deterioration (PSD) increments are the maximum amounts of pollutants allowed above a specified baseline concentration. Class I areas are predominantly large national parks and wilderness areas as of August 7, 1977.
[3] The 1-hour NAAQS will no longer apply to an area 1 year after the effective date of the designation of that area for the 8-hour ozone NAAQS. The effective designation date for most areas is June 15, 2004.
NA = Not applicable.

very small amount or increment of air quality deterioration is permissible. Class I areas include specified national parks, wilderness areas, and certain Indian reservations (Map 3-2). Mandatory Class I areas, which include large national parks and wilderness areas that were in existence on August 7, 1977, are a subset of Class I areas that may not be redesignated, and are subject to visibility protection regulations. All areas that have not been designated Class I are considered Class II areas. The PSD permit provisions of the Clean Air Act only apply to stationary sources of air pollution and do not include prescribed fire, which is defined as a temporary source. Some states, however, have regulations to restrict intrusions of smoke from prescribed burning that might adversely impact visibility within mandatory federal Class I and other smoke-sensitive areas.

Detailed knowledge of the existing air quality for the area covered by this PER is limited to available monitoring sites for criteria pollutants. In the undeveloped regions of public lands, ambient pollutant levels are expected to be low, and probably negligible in remote areas. In general, locations experiencing high ambient pollutant levels in the treatment area are areas with commercial and industrial land use (areas with mills, power plants, etc.), and local population centers (areas with automobile exhaust, residential heating, etc.).

Table 3-3 lists counties with public lands that are designated as nonattainment or maintenance areas for each criteria pollutant. PM_{10}, O_3, and NO_2 concentrations are expected to be higher near industrial areas and cities where there are significant combustion sources and vehicles. High SO_2 concentrations occur primarily near coal-fired power plants, smelters, and refineries.

Visibility Protection in Mandatory Federal Class I Areas

Under the Clean Air Act, Congress created the Grand Canyon Visibility and Transport Commission (GCVTC). The GCVTC was comprised of eight western states, six tribal agencies, and four federal land management agencies, and was charged with assessing the current scientific information on

TABLE 3-3
Counties within the Treatment Area that are Designated Nonattainment or Maintenance Areas for Various Pollutants

Pollutant	State	Nonattainment	Maintenance
PM_{10}	Arizona	Cochise*, Gila*, Maricopa*, Pima*, Pinal*, Santa Cruz*, Yuma*	Gila*, Mohave*
	California	Fresno*, Imperial*, Inyo*, Kern*, Kings*, Madera*, Mono*, Riverside*, San Bernardino, Stanislaus*, Tulare*	Kern*, Mono*
	Colorado	Prowers*	Adams*, Arapahoe*, Archuleta*, Boulder*, Broomfield, Denver, Douglas, Freemont*, Jefferson, Pitkin*, Routt*, San Miguel*
	Idaho	Bannock*, Bonner, Power*, Shoshone*	Ada*
	Montana	Missoula*, Rosebud*, Silver Bow*	None
	Nevada	Clark*, Washoe*	None
	New Mexico	Dona Ana*	None
	Oregon	Jackson*, Lake*, Lane*	Josephine*, Klamath*
	Utah	Salt Lake, Utah	None
	Washington	Yakima*	None
	Wyoming	Sheridan*	None
SO_2	Arizona	Cochise*, Gila*, Pinal*	Greenlee*, Pima*
	Montana	Lewis and Clark*, Yellowstone*	None
	Nevada	None	White Pine*
	New Mexico	None	Grant*
	Utah	Salt Lake*, Tooele*	None
NO_2	None	None	None
CO	Alaska	None	Fairbanks North Star*
	Arizona	Maricopa*	Pima*
	California	Los Angeles*, Riverside*, San Bernardino*	Butte*, El Dorado*, Fresno*, Kern*, Napa*, Placer*, San Diego*, Solano*, Sonoma*, Stanislaus*, Yolo*
	Colorado	None	Boulder*, El Paso*, Jefferson*, Larimer*, Teller*
	Idaho	None	Ada*
	Montana	Missoula*	Cascade*, Yellowstone*
	Nevada	None	Carson City*, Douglas*, Washoe*
	New Mexico	None	Bernalillo
	Oregon	Marion*, Polk*	Clackamas*, Jackson*, Josephine*, Klamath*, Lane*, Washington*
	Utah	Utah*	Salt Lake
	Washington	Spokane*	Yakima*
Ozone	Arizona	Maricopa*	None
	California	Butte, El Dorado*, Fresno*, Imperial, Kern*, Kings, Napa*, Placer*, Riverside*, San Bernardino*, San Diego*, Solano*, Sonoma*, Stanislaus, Tulare, Yolo	Kern*, Monterey, San Benito, San Diego
	Colorado	None	Boulder*, Jefferson
	Nevada	Washoe	Clark*, King*, Pierce*, Snohomish*, Yakima*
	New Mexico	Dona Ana*	None
	Oregon	Marion*, Polk*	Clackamas*, Washington*
	Utah	None	Salt Lake
Lead	Montana	Lewis and Clark*	None

* Only a portion of the county is in nonattainment or maintenance for the pollutant.
Notes: States that are not listed for a particular pollutant do not have counties within the treatment area that are also within nonattainment or maintenance areas for that pollutant.
Source: USEPA Green Book available at http://www.epa.gov/oar/oaqps/greenbk/.

visibility impacts and making recommendations for addressing regional haze in the western U.S (GCVTC 1996). The GCVTC signed and submitted more than 70 recommendations to the USEPA indicating that visibility impairment was caused by a wide variety of sources and pollutants, and that a comprehensive strategy was needed to remedy regional haze (Western Governors' Association 1996). Based on the findings and recommendations from the GCVTC, the USEPA established regional haze regulations, and encouraged states to coordinate their implementation efforts through regional planning organizations.

The Western Regional Air Partnership (WRAP) was established in 1997 as a successor to the GCVTC. The WRAP is a voluntary organization comprised of 13 western governors (Alaska, Arizona, California, Colorado, Idaho, Montana, North Dakota, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming), 11 tribal leaders, and 2 federal departments (USDA and USDI).

In the 1990 amendments to the Clean Air Act, the U.S. Congress directed the USEPA to develop regional haze regulations to achieve the national visibility goal of "the prevention of any future, and the remedying of any existing impairment of visibility in mandatory Class I federal areas, which impairment results from manmade air pollution."

The USEPA promulgated the Regional Haze Rule in 1999 to improve visibility in 156 mandatory federal Class I national parks and wilderness areas where visibility is an important value (USEPA 1999a). Improvement in visibility must be made every 10 years for the 20% most impaired (haziest) days, and there must be no degradation for the 20% best (clearest) days, until the national visibility goal is reached in 2064. State implementation plans and tribal implementation plans (TIPs) outline how reasonable progress towards this goal will be achieved and demonstrated. Section 308 of the Regional Haze Rule provides nationally applicable provisions of the rule in the development of SIPs and TIPs, which address regional haze.

Smoke Management Policies and Regulations

In 1998, in cooperation with several federal land management agencies, the USEPA issued the Interim Air Quality Policy on Wildland and Prescribed Fires, a national policy on how best to achieve national clean air goals (including the PM NAAQS) while improving the quality of natural ecosystems through the increased use of wildland and prescribed fire (USEPA 1998a). It provides guidance to federal land management agencies on how best to manage fires on wildlands, and provides incentives to state and tribal entities to implement programs to minimize smoke impacts and meet air quality goals.

According to a survey of over 100 government agencies in the western states and Alaska, most state and local agencies require that a prescribed burning project be pre-registered with the state agency (USDI BLM 2003a). In most locations, no open burning activities may be undertaken without first obtaining a proper permit from the appropriate regulatory agency, unless specifically exempted by law. Applications for open burning permits usually require submitting information on the amount and type of material to be burned, burn location and dates, reasons for the burn and alternative treatment options, potential impacts, contact information, predicted weather conditions, contingency actions, and smoke management methods.

Once a prescribed burn permit application is submitted to the applicable permitting agency (including payment of any required fees), the application is reviewed and discussed with the permittee. An agency will issue or deny the permit, usually with restrictions or conditions. A preliminary burn date is established, and frequent communication with the agency up to the burn day is usually required. On the scheduled day of the burn, the regulatory agency will issue the burn forecast and authorization to burn. If approved, the burn then commences until the objectives of the burn are met, after which time the fire is extinguished. Land managers conducting prescribed burning must implement actions to reduce and disperse smoke emissions. These actions can include using mass ignition (aerial) techniques, conducting burns under favorable weather conditions, spreading impacts over a broad time period and geographical area, and using predictive modeling.

The BLM prepares prescribed fire plans for prescribed burning activities, following guidance in the *Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide* (USDA and USDI 2006b) and the BLM Supplement to this guide. This guidance provides information on how to use prescribed fire in a safe, controlled, and cost-effective manner to achieve the management objectives defined in applicable resource and fire management plans. It also specifies that compliance with federal, state, and local air quality regulations is mandatory, coordination with applicable air regulatory agencies is

necessary, and staff should participate in state and local rule making and periodic reviews.

In addition, an evaluation of smoke dispersal conditions, including meteorological information, is often conducted to determine the potential impacts of the smoke plume. Contingency plans may also be developed to identify actions to be taken if the requirements of the fire plan are exceeded.

Wildland Fires, Prescribed Fire, and Wildland Fire Use

Since 1990, approximately 9 acres of public lands have been burned by wildfires for every acre burned by prescribed fire. Wildfire events require a Wildland Fire Situation Analysis to determine the appropriate management response. Prescribed fires are management-ignited wildland fires that burn under specified conditions and in predetermined areas, and that produce the fire behavior and fire characteristics required to achieve resource management objectives. A written, approved prescribed fire plan must exist, and NEPA requirements must be met prior to ignition. Wildland fire use is the application of the appropriate management response to naturally-ignited wildland fires to accomplish specific resource management objectives in predefined designated areas outlined in Fire Management Plans. Wildand fire use requires a Wildland Fire Implementation Plan that assesses, analyzes, and selects an appropriate management response. For all three types of wildland fire, impacts to air quality are considered in determining the strategy and tactics for management.

Carefully planned and implemented prescribed fire should produce far less smoke impact to air quality than uncontrolled wildfires. Unlike wildfire, the impacts of smoke from prescribed fire are managed. Where smoke impacts from prescribed fire are of concern, fuel accumulations can be reduced through manual, mechanical, or chemical treatments prior to, or instead of, prescribed burning. Smoke impacts can also be reduced through scheduling burning when the wind is blowing away from smoke-sensitive areas and during good dispersion conditions (Hardy et al. 2001). Scheduling prescribed burns before new fuels accumulate can reduce the amount of emissions produced. Fire managers can also reduce the amount of area burned, increase the combustion efficiency of a burn, and increase the plume height in order to reduce smoke impacts to air quality.

Standard Operating Procedures for Managing Prescribed Burning

As discussed in *The Smoke Management Guide for Prescribed and Wildland Fire 2001 Edition*, the BLM and other agencies that use fire focus on two different approaches to managing smoke: 1) reduction of emissions, and 2) redistribution of emissions through a knowledge of climate and associated meteorological conditions (National Wildfire Coordinating Group 2001). The techniques used to reduce emissions are to: 1) reduce the area burned, 2) reduce the amount of fuels burned (total fuel loading), 3) reduce biomass (fuel) production, 4) reduce the amount of fuel consumed (refers to fuel moisture), 5) burn before new biomass appears, and 6) increase the combustion efficiency. The techniques used to redistribute the emissions focus on 1) burning when dispersion is good, 2) scheduling burns to minimize cumulative impacts, 3) avoiding sensitive areas, 4) burning smaller areas, and 5) burning more frequently. Typically, a combination of these methods is implemented over time to increase effectiveness. It should be noted that several of these techniques are specifically targeted for forest ecosystems and would be less effective in rangeland conditions.

Herbicide Drift

Aerial and ground application of herbicides may transport herbicides through drift, allowing airborne herbicides to move beyond the intended target. The primary factors that influence drift are droplet size, wind speed, humidity, formulation of the herbicide, height of emission, equipment and application techniques, and the size of the area treated with the herbicide. The factor that has the greatest influence on downwind movement is droplet size. Procedures that can be employed to reduce drift include: 1) using a lower spray nozzle height, 2) using the lower end of the pressure range, 3) increasing the spray nozzle size, 4) using drift-reducing nozzles, 5) using drift control additives, and 6) using sprayer shields (Hofman and Solseng 2001). Additionally, several university extension service agencies provide assistance regarding SOPs to minimize herbicide spray drift (Dexter 1993, Hofman and Solseng 2001).

Topography, Geology, Minerals, Oil, and Gas

The diversity in the landscape of the treatment areas reflects differences in geologic processes and the effects of climate, which have been shaping the land over a long period of time.

In 2005, on-shore public lands produced about 40% of the nation's coal, about 11% of its natural gas, and about 5% of its oil (USDI BLM 2006b). In FY 2005, the BLM administered over 54,000 oil and gas leases, of which approximately 21,000 leases were producing. BLM geothermal resources produced over 34 megawatt-hours of electric power. Information pertaining to mineral, oil, and gas resources, presented below, was gathered from the Mineral Resources Program, a section of the U.S. Geological Survey (USGS).

Tundra Ecoregion

The Tundra Ecoregion is rich in minerals, oil, and gas. Metallic minerals including silver, lead, and zinc are found throughout the North Slope region of Alaska. To the south, along the western coast of Alaska, are significant concentrations of gold. The Northern Alaska physiographic province accounts for almost half of the oil and more than half of the undiscovered conventional gas assessed on onshore federal lands. Oil and coal resources extracted in Alaska are predominantly from the Tundra Ecoregion (i.e., North Slope). As of 2005, Alaska accounted for 17% of the crude oil discovered in the U.S. (Energy Information Administration 2006).

Subarctic Ecoregion

Gold is the most dominant mineral extracted in this ecoregion. Other mineral operations include copper mining, and production of aggregate (e.g., construction sand, gravel, and crushed stone). There are limited discoveries of coal, gas, and oil resources in the central portion of Alaska.

Temperate Desert Ecoregion

Raw, non-fuel minerals extracted throughout this ecoregion include aggregate, gypsum, limestone, trona, shale, and stone. Metallic minerals, predominantly silver and gold, are extracted in the southern portions of this ecoregion. There is very little oil and gas found in this ecoregion. However, coalfields located in the Temperate Steppe Ecoregion extend into this ecoregion, and are found throughout southwest Wyoming and central and southwest Utah.

Subtropical Desert Ecoregion

Minerals predominantly extracted from the western portion of this ecoregion are construction aggregate including construction sand, gravel, and crushed stone. Metallic minerals (e.g., gold, silver, and copper) dominate the central and eastern portion of this region. Gypsum is prominent in southern Nevada. Limited oil and gas reserves are located in southern Arizona and southwest New Mexico. No coalfields are found in this ecoregion.

Temperate Steppe Ecoregion

Construction aggregate (including crushed stone and common clay) is the dominant mineral extracted throughout the southern and central sections of this ecoregion. While industrial minerals within this region are predominantly extracted for construction purposes, Wyoming contains the world's largest source of trona. Trona is the principal ore from which soda ash is produced. Metallic minerals and precious stones (i.e., gems) are extracted throughout the northern and northeastern portions of the ecoregion.

There are significant deposits of coal concentrated throughout the Colorado Plateau extending into the Rocky Mountains and Great Plains. Significant oil reserves are located throughout the region (Map 3-3). The Powder River Basin and the Wyoming Thrust Belt provinces of the Rocky Mountains and Northern Great Plains regions have the second largest concentrations (behind Alaska) of undiscovered conventional oil and gas, respectively, assessed on federal lands (Gautier et al. 1998; U.S. Departments of Interior, Agriculture, and Energy 2003).

Subtropical Steppe Ecoregion

Construction aggregate and metallic minerals dominate the nonfuel minerals extracted in this ecoregion. In addition, potash accounts for a significant portion of minerals mined in New Mexico. The Carlsbad Potash District (in New Mexico) is the largest potash-producing area in the U.S. (Energy Information Administration 2001). There are extensive coalfields throughout northern Arizona and New Mexico. These fields extend up into the Colorado Plateau. No oil or natural gas reserves have been located in this ecoregion.

Mediterranean Ecoregion

Industrial minerals such as aggregate, limestone, and shale dominate mineral extraction throughout this ecoregion. There is no coal mining within this ecoregion, although oil and natural gas extraction is predominant in the San Joaquin, Ventura/Santa Barbara, Los Angeles, and Santa Maria regions.

Marine Ecoregion

Metallic minerals such as gold, silver, aluminum, lead, and zinc are mined in southeast Alaska and in Washington. In western Oregon, aggregate is the most dominant mineral extracted. There are no significant oil, natural gas, or coal resources within this region.

Soil Resources

Soils in the treatment area are diverse and range from the arid, saline soils of the southwest, to the clayey glaciated soils of Montana, to the cold, wet permafrost soils of Alaska. Soils are the result of complex interactions between parent material (geology), climate, topography, organisms, and time (Brady and Weil 1999). Soils are classified by the degree of development into distinct layers or horizons and their prevailing physical and chemical properties (Fanning and Fanning 1989). Similar soil types are grouped together into soil orders based on defining characteristics, such as organic matter and clay content, amount of mineral weathering, water and temperature regimes, or other characteristics that give soil unique properties, such as the presence of volcanic ash or permafrost (Jenny 1980).

Eleven soil orders are represented on public lands in the western U.S. and Alaska (Map 3-4). Because soils develop under local conditions of climate, parent material, and vegetation, each ecoregion may contain several or all of the soil orders as a result of various combinations of local soil forming factors. Soils are organized here by soil order rather than by ecoregion.

Aridisols are found on over 40% of public lands (105 million acres). They occur across wide parts of the western U.S. in Nevada, Arizona, New Mexico, central Wyoming, southern Idaho, and southern California. These soils are characterized by an extreme water deficiency. They are light colored soils, are low in organic matter, and may have subsurface accumulations of soluble materials, such as calcium carbonate, silica, gypsum, soluble salts, and exchangeable sodium. Vegetation on these soils includes scattered desert shrubs and short bunchgrasses, which are important resources for livestock. Aridisols are generally not very productive without irrigation, and may be prone to salinity buildup. Surface mineral deposits often form physical crusts that impede water infiltration.

Gelisols occur on over 27% of public lands (71 million acres), almost exclusively in the tundra regions of Alaska. They are underlain by permanently frozen ground (permafrost). Some gelisols in wet environments have developed large accumulations of organic matter, particularly in areas of bogs and wetlands. Soil forming processes take place very slowly above the permafrost in the active layer that thaws seasonally. These soils support tundra vegetation of lichens, grasses, and low shrubs that grow during the brief summers. Plant productivity is low and limited by the extremely short growing season of the northern latitudes, low levels of solar radiation, and poor water drainage. Bare rock is also common in Alaska, comprising nearly 8 million acres.

Mollisols occur on about 15% of public lands (40 million acres). They are found in much of North and South Dakota and northern Montana, as well as in eastern Oregon, Washington, and Idaho where they have developed from basalt and loess parent materials. These soils typically support grasslands and are mineral soils with thick, dark-colored surface horizons rich in organic matter from the dense root systems of prairie grasses. They are one of the most productive soils on public lands, and their high organic matter content helps reduce the risk of groundwater contamination by herbicides. Mollisols extend from upland areas to the prairie grasslands, where they are most abundant. Mollisols support a variety of plant communities, including grasslands, chaparral-mountain shrub, and forests. Since they have developed primarily under grassland vegetation, mollisols have been used extensively for livestock grazing.

Entisols occur on about 9% of public lands (23 million acres). Entisols occur extensively in eastern Montana, western Colorado, South Dakota, Wyoming, Utah, and central California. They are young, weakly developed mineral soils that lack significant profile development (soil horizons) and are often found in lower elevation, arid and semiarid environments supporting desert shrub and sagebrush communities. Entisols can include recent alluvium, sands, soils on steep slopes, and shallow soils. Soil productivity ranges from very low in soils forming in shifting sand or on steep rocky slopes to very high in certain soils formed in recent alluvium. Productivity is often limited by shallow soil depth, low water holding

capacity, or inadequate available moisture, but these soils do support rangeland vegetation and may support trees in areas of higher precipitation.

Alfisols occur on less than 2% of public lands (4 million acres). They can be found throughout the mountains of western Montana and Wyoming and in central Colorado and California. They are characterized by subsurface clay accumulations and nutrient-enriched subsoil. Alfisols commonly have a mixed vegetative cover and are productive for most crops, including commercial timber.

Inceptisols also occur on less than 2% of public lands (4 million acres). Inceptisols are found in northern Idaho and parts of Washington, Oregon, and Montana, as well as southwest Alaska. They are generally young mineral soils, but have had more time to develop profile characteristics than Entisols. They principally occur in very cool to warm, humid and subhumid regions and in most physiographic conditions, and often support coniferous and deciduous forests as well as rangeland vegetation. They may form in resistant rock or thin volcanic ash on steep mountain slopes or depressions, on top of mountain peaks, or next to rivers. Productivity is varied and may be high where moisture is adequate.

The other soil orders represent less than 1% of public lands each (1 million acres or less), and therefore, will not be discussed in detail. **Andisols** are soils that have formed on volcanic ash deposits. They have high amounts of volcanic glass and organic matter, giving them a light, fluffy texture. **Histosols** are organic soils that typically form in lowland areas with poor water drainage. While not extensive, Histosols are often associated with riparian or wetland resources and can be very important locally.

Spodosols are highly leached, acid soils that typically form on sandy soils under cold, humid conditions at high elevations. **Ultisols** are strongly acid mineral soils associated with advanced soil weathering and are low in nutrients. **Vertisols** have large amounts of expanding clay that causes them to have high shrinking and swelling characteristics.

The concept of soil quality encompasses a soil's capacity to function and to sustain plant and animal productivity, air and water quality, and human health (Soil Quality Institute 2001). It is a function of each soil's inherited properties (texture, type of minerals, depth) as well as more dynamic properties that can change with management (porosity, infiltration, effective ground cover, and aggregate stability). The ability of a soil to filter, buffer, degrade, immobilize, and detoxify herbicides is a function of the soil quality.

Management activities can result in changes in certain soil properties such as soil porosity, organic matter, biological activity, and susceptibility to erosion. These changes in turn affect the fate of herbicides in soils. For example, disturbances that result in increased susceptibility to erosion will affect the off-site movement of certain herbicides that are designed to bind to soil particles. Herbicides can alter soil organism diversity and composition. Compaction or surface disturbance may affect soil activated herbicides from reaching the root zone of target plants.

Biological Soil Crusts

Biological soil crusts (also known as cryptogamic, microbiotic, cryptobiotic, or microphytic crusts) are commonly found in semiarid and arid environments. They provide important functions, such as improving soil stability and reducing erosion, fixing atmospheric nitrogen and contributing nutrients to plants, and assisting with plant growth (Belnap and Gardner 1993, Evans and Ehleringer 1993, Eldridge and Greene 1994, Belnap and Giliette 1998, Harper and Belnap 2001). Crusts are composed of a highly specialized nonvascular plant community consisting of cyanobacteria, green and brown algae, mosses, and lichens, as well as liverworts, fungi, and bacteria (Belnap and Phillips 2001). Biological soil crusts occupy open spaces between the sparse vegetation of the Great Basin, Colorado Plateau, Sonoran Desert, and the inner Columbia Basin, and also occur in agricultural areas and native prairies, and in Alaska.

Biological soil crusts can reach up to several inches in thickness and vary in terms of color, surface topography, and surficial coverage. Crusts generally cover all soil spaces not occupied by vascular plants, which may be 70% or more in arid regions (Belnap 1994). They are well adapted to severe growing conditions, but are influenced by disturbances such as compression from domestic livestock grazing, tourist activities (hiking, biking, and OHVs), mechanical treatment and agricultural practices (extensive tillage and planting), application of herbicides, and military activities (Peterjohn and Schlesinger 1990, Belnap 1995, USGS 2004a). Disturbance of biological crusts results in decreased soil organism diversity, nutrients, stability, and organic matter. Trampling may reduce the number of crust organisms found on the surface and increase runoff and the rate of soil loss without apparent

damage to vegetation (Eldridge 1996). Burial of crusts by sediments kills non-mobile photosynthetic components (mosses, lichens, and green algae) of the crust (Campbell 1979). Fires can cause severe damage to biological crusts, but recovery is possible, depending on fire size and intensity. Shrub presence (particularly sagebrush) may increase fire intensity, thereby decreasing the likelihood of early vegetative or crust recovery after a burn (USGS 2003).

Micro and Macroorganisms

Microorganisms help to break down and convert organic remains into forms that can be used by plants. Microorganisms, such as mycorrhizal fungi, nitrogen-fixing organisms, and certain types of bacteria assist plant growth, suppress plant pathogens, and build soil structure. One of the main benefits of mycorrhizal fungi is the improved uptake of nutrients (predominantly phosphorous) and water by plants (Allen 1991). Soil microorganisms are also important in the breakdown of certain types of herbicides.

Macroorganisms, such as insects, earthworms, and small burrowing mammals, mix the soil and allow organic matter on the surface to become incorporated into the soil. These organisms are part of a food chain that is essential to the cycling of nutrients within the soil. Soil microorganisms are also important in the breakdown of certain types of pesticides.

Soil Erosion

Soil erosion is a concern throughout the western U.S. and Alaska, particularly in semiarid rangelands. The quantity of soil lost by water or wind erosion is influenced by climate, topography, soil properties, vegetative cover, and land use. While erosion occurs under natural conditions, rates of soil loss may be accelerated if human activities are not carefully managed.

Tundra lands in Alaska are susceptible to erosion if the thick vegetative mat overlying permafrost is disturbed or removed. Trails quickly turn into widely braided ruts, especially in wetlands and at streambank crossings. The resulting gully erosion can rapidly erode substantial quantities of previously frozen soils. Erosion from aufeis (thick ice that builds ups as a result of repeated overflow) and anchor ice is also a concern due to spring breakup flood events leaving disturbed streamchannels. These events cause previously stable riparian areas to form a long-lasting sequence of extensively braided channels, especially in glacial soils.

Rangelands are affected by all four types of water erosion—sheet, rill, gully, and streambank. Sheet erosion is relatively uniform erosion from the entire soil surface and is therefore often difficult to observe, while rill erosion is initiated when water concentrates in small channels as it runs off the soil. Sheet and rill erosion are capable of reducing the productivity of rangeland soils, but often go unnoticed. Gully and streambank erosion is far more visible, and may account for up to 75% of erosion in desert ecosystems (Hein 2002). Changes in water flow patterns in arid areas resulting from thunderstorms and fire events can cause an increase in the size and frequency of runoff events and sediment yield to local water sources (Water Science and Technology Board and Board on Environmental Studies and Toxicology 2002).

It is possible to control rates of soil erosion by managing vegetation, plant residues, and soil disturbance. Vegetative cover is the most significant factor in controlling erosion because it intercepts precipitation, reduces rainfall impact, restricts overland flow, and improves infiltration. Biological soil crusts are particularly important for protecting the soil and controlling erosion in desert regions, but are easily disturbed by grazing and human activities.

With a decrease in vegetative cover, the potential risk of herbicides entering surface water and groundwater can increase (Purdue Pesticide Program 2001). Herbicides can be transported by surface water runoff, potentially increasing the risk of direct injury to nontarget species, harming aquatic organisms in streams and ponds, and leading to groundwater contamination (University of Missouri Extension 1997).

Differences in chemical solubility, adsorptive characteristics, volatility, and degradability, plus soil properties that affect water movement, biological activity, and chemical retention, affect the amount of a herbicide that may leach to groundwater. The speed at which leaching of chemicals through soil occurs is dependent on the soil characteristics. Soil texture (sand, silt, and clay) affects the movement of water and herbicides through soil. The coarser the soil, the faster the movement of percolating water and the lower the opportunity for adsorption of dissolved chemicals. Soils with more clay and organic matter tend to hold water and dissolved chemicals longer. These soils also have far more surface area onto which herbicides can be adsorbed (LaPrade 1992).

Wind erosion is most common in arid and semiarid regions where lack of soil moisture greatly reduces the adhesive capability of soil (Brady and Weil 2002). In addition to moisture content, soil particle size (texture), mechanical stability of aggregates and clods, and presence of vegetation also affect the ability of wind to move soil. While wind erosion on rangelands is difficult to quantify, the presence of natural vegetation on most rangelands is generally sufficient to keep wind erosion from becoming a serious problem. Most wind erosion problems result from bare, exposed soils with weak or degraded soil structure, such as along trails or on sand dunes or disturbed surfaces. Herbicides can be potentially transported by blowing soils after application. Herbicides bound to soil particles may be moved offsite by wind erosion events.

Soil Compaction

Soil compaction occurs when moist or wet soil aggregates are pressed together and the pore space between them is reduced. Compaction changes soil structure, reduces the size and continuity of pores, and increases soil density. Wheel traffic, large animals, vehicles, and people can cause soil compaction. Generally, soils made up of particles of about the same size compact less than soil with a variety of particle sizes. Numerous rock fragments can create bridges that reduce compaction. Plant litter and roots, and soil organic matter, structure, moisture, and texture all affect a soil's ability to resist compaction. In areas of rangeland where compaction exists, compacted soil extends generally less than 6 inches below the soil surface, although it can be as deep as 2 feet under heavily used tracks and roads (USDA Natural Resource Conservation Service 1996). Compaction becomes a problem when the increased soil density limits water infiltration, increases runoff and erosion, or limits plant growth or nutrient cycling (Soil Quality Institute 2001).

Water Resources and Quality

Water Resources

Water resources in the western U.S. and Alaska are important for fish and wildlife habitat and a variety of human needs, such as domestic consumption, industrial activities, crop irrigation, livestock watering, and recreation. Numerous legal and policy requirements have been established to manage water resources for these multiple needs, including the Clean Water Act, the Colorado River Basin Salinity Control Act, and EO 11988 (*Floodplain Management*).

Water resources are classified as surface water or groundwater. Surface water resources include rivers, streams, lakes, ponds, reservoirs, and wetlands. Major river systems (e.g., Colorado, Columbia, Snake, Missouri, Arkansas, Rio Grande, and Yukon rivers) and their tributaries are important sources of water in the western U.S and Alaska.

The quantity and quality of surface water resources are affected by precipitation, topography, soil type, vegetation, agricultural practices, urbanization, and general land use practices, especially for large tracts of public land. The alteration of vegetative cover from land use practices can have significant impacts on water infiltration, soil erosion, and stream sedimentation.

The largest quantities of useable freshwater occur as groundwater, which provides drinking water for more than 97% of the rural population without access to public-water supplies, and between 30 and 40% of the water used for agriculture (Alley et al. 1999). Groundwater is obtained primarily from wells that tap into aquifers. Aquifers are layers of permeable rocks that are recharged with freshwater from precipitation that percolates through the unsaturated zone to the water table, typically in upland, mountainous areas. Recharge rates generally range from a tiny fraction to about one-half of the average annual precipitation. Streams are commonly a significant source of recharge to groundwater downstream from mountain fronts and steep hillslopes in arid and semiarid areas.

As shown on Map 3-5, nine hydrologic regions have been identified in the treatment area: Alaska, Pacific Northwest, California, Upper Colorado, Lower Colorado, Rio Grande, Missouri, Great Basin, and Arkansas-White-Red (Seaber et al. 1987). Most public lands occur in arid to semiarid environments in the Great Basin and Colorado drainage basins.

Alaska Hydrologic Region

The BLM administers approximately 143,000 miles of riparian habitat and nearly 12.6 million acres of wetlands in Alaska (USDI BLM 2006d). This hydrologic region occupies the entire state of Alaska, and is characterized by an abundance of water resources. Major river systems, such as the Yukon, drain the mountain ranges, and extensive wetlands dot the low-lying plains and coastal regions.

The Yukon and Kuskokwim river drainages are two of the dominant drainages in Alaska. The Yukon River drains an area of more than 330,000 square miles (mi^2), making it the fourth largest drainage basin in North America. Its mainstem, the Yukon River, originates in northwestern Canada and extends through central Alaska, discharging into the Bering Sea (Brabets et al. 2000). Major tributaries of the Yukon River include the Tanana, Nenana, and Chena rivers.

The Kuskokwim River is the second largest drainage in Alaska. The glacially turbid mainstem is approximately 900 miles long, originating from the interior headwaters of the Kuskokwim Mountains and the shadows of the Alaska Range. The Kuskokwim River flows in a southwest direction to the Bering Sea.

Hydrologic processes are strongly affected by the presence of permafrost, which may thaw seasonally or be continuous throughout the year, particularly in the North Slope. In central Alaska, permafrost is discontinuous, and an active layer at the surface that thaws during the summer months can supply groundwater for domestic use. The valleys of major rivers have alluvial aquifers with an active layer in the summer months that also supply good quality groundwater. During the winter, permafrost generally extends to the surface, impeding water infiltration and groundwater recharge.

Pacific Northwest Hydrologic Region

The Pacific Northwest Hydrologic Region includes the wet coastal areas of Oregon and Washington, as well as the semiarid Columbia Plateau in eastern Washington, Oregon, and southern Idaho. The region is drained by the Columbia, Willamette, and Snake River systems, which are important sources of hydroelectric power and irrigation for agriculture.

The coastal areas of Oregon and Washington are influenced by medium to high rainfall levels due to the interaction between marine weather systems and the mountainous nature of the region. Mountains within this area are generally rugged with steep canyons. Tributary streams are short and have steep gradients, creating rapid surface water runoff with relatively short-term water storage, limiting recharge.

The Columbia River Basin drains approximately 259,000 mi^2. The basin extends roughly from the crest of the Coast Ranges of Oregon and Washington, east through Idaho, to the Continental Divide in the Rocky Mountains of Montana and Wyoming; and from the headwaters of the Columbia River in Canada to the high desert of northern Nevada and northwestern Utah. Its mainstem, the Columbia River, originates in two lakes that lie between the Continental Divide and the Selkirk Mountain Range in British Columbia. After flowing a circuitous path for approximately 1,200 miles, it joins the Pacific Ocean near Astoria, Oregon.

The Columbia River has 10 major tributaries—the Kootenay, Okanagan, Wenatchee, Spokane, Yakima, Snake, Deschutes, Willamette, Cowlitz, and Lewis rivers.

The Pacific Northwest Hydrologic Region includes a network of coastal streams and rivers. Many are rain-driven systems that are hydrologically flashy and influenced primarily by rain storms during the winter. Streams west of the Cascade Range typically discharge directly into the Pacific Ocean.

The southernmost portion of this hydrologic region extends down to the northern portion of the Great Basin. This area is geologically very new and contains extensive areas of lava and other volcanic rock. The rock substrata are very permeable; therefore, streams tend to lose much of their flow through percolation. Only large rivers that lie below the water table contain substantial flows year-round. In most years, abundant precipitation along the western side of the Cascade Range produces abundant surface water flow in streams flowing off the Cascade Range to the Pacific Ocean. Aridity progressively increases and precipitation decreases east of the Cascade Range because of rainshadow effects caused by the mountains.

Timing of precipitation east of the Cascade Range coincides with periods of relatively high solar radiation; thus, precipitation is rapidly evaporated, limiting the amount of surface water available to streams in this portion of the region (Spence et al. 1996). Generally, streams that flow year-round east of the Cascade Range are fed by snowmelt from higher elevations or by groundwater discharge from aquifers recharged during periods of abundant precipitation.

Groundwater is an important resource in this hydrologic region for domestic consumption and irrigation, particularly when surface water supplies are insufficient. It is generally contained in shallow alluvial aquifers along major streams and their valleys.

California Hydrologic Region

This hydrologic region includes nearly the entire state of California, as well as parts of southern Oregon. The region is characterized by a Mediterranean climate with winter precipitation, and a prolonged summer period with little precipitation.

The California region is drained by rivers such as the Sacramento and San Joaquin. Surface water flow in streams is derived mainly from snowmelt in the mountainous areas during the spring months. During the remainder of the year, many streams have no flow or intermittent flow that follows major storms.

Groundwater in the mountainous areas is relatively deep, and is contained in sedimentary units that continue under the intermountain basins and form a deep reservoir that is seldom tapped because of its depth. Shallow groundwater can be found in sands and gravels that fill the basins between the mountain ranges. This groundwater is fed by infiltration of surface water from streams that flow off the mountain ranges. Groundwater in southeastern California is the main source of water for domestic consumption and agricultural irrigation.

Upper Colorado Hydrologic Region

This hydrologic region includes the Colorado Plateau, which encompasses parts of southern Wyoming, western Colorado, eastern Utah, and northern Arizona and New Mexico. The upper reaches of the Colorado River and its tributaries drain this region. Precipitation varies greatly with elevation, and occurs as winter snows and heavy fall rainstorms.

Perennial surface water flow occurs in major rivers (e.g., the Green River and Colorado River). Major streams are fed by snowmelt in the mountainous areas. Dams serve as flood control, domestic supply, and power generation for the major urban centers, as well as provide surface water for irrigation. Intermittent flow occurs in tributaries to the major rivers, and ephemeral flow occurs in small canyons. Surface water runoff or groundwater baseflow are the major processes that deliver precipitation and snowmelt to streams. In Colorado, the annual hydrograph for most streams is dominated by snowmelt in the mountains; however, there is also a rain component, which varies by region. For instance, in the southwest portion of Colorado, summer monsoonal flow produces ample rain. The larger rivers in Colorado are perennial, but the smaller rivers and streams are either intermittent or ephemeral.

Groundwater is found in most of the sedimentary rocks of the Colorado Plateau, and is the major source of water for domestic and municipal use. Major aquifer systems are not present; groundwater is localized and can be abundant in some areas and absent in others. Farming and ranching are usually limited to stream valleys, where irrigation water comes mostly from surface water. Groundwater baseflow is the major source of water for perennial flows in the late summer and early fall. Seeps and springs are an historic source of water for Native American tribes and a current source of water for smaller ranches.

Lower Colorado Hydrologic Region

This hydrologic region is comprised of the lower reaches of the Colorado River in the desert southwest of Arizona, New Mexico, and southern Nevada. In this region, public lands are mainly restricted to the arid valleys, while many of the upland areas are administered by the Forest Service. The climate is arid, and precipitation is limited to the winter months and periods of heavy storms. Most precipitation during summer evaporates before it can infiltrate into the desert sands.

Surface water flow in the arid basins of the southwest is ephemeral to non-existent most of the year. Spring snowmelt and periods of heavy rain during the winter result in surface water flow in the mountainous areas and along the mountain fronts in the intervening basins. During the rest of the year, surface water flow is absent except after major storms, where flash floods are common along the mountain fronts. Only major rivers draining the Colorado Plateau or the Mogollon Rim, such as the Gila and Bill Williams rivers, have perennial flow.

Groundwater is found in the alluvium of the basins and in the bedrock of the mountainous areas (i.e., deep reservoirs to depths of many thousands of feet). Groundwater is recharged by precipitation in the mountains and infiltration of stream flow along the base of the mountains. The shallow groundwater reservoirs are used extensively for irrigation and domestic consumption. Irrigation demand and mine dewatering have substantially lowered the water levels in the shallow groundwater reservoirs of the Arizona basins. However, groundwater levels in the basins of southern New Mexico have not been substantially affected by irrigation. Many of the basins have shallow groundwater surfacing in playa lakes.

Rio Grande Hydrologic Region

This region occupies central New Mexico and western Texas. The Rio Grande and Pecos rivers are major surface water resources that derive their water from the mountainous regions of southern Colorado and flow through New Mexico to the Gulf of Mexico. Surface water flow is present year-round in the Rio Grande and is caused by spring snowmelt and summer monsoon thunderstorms. Agricultural diversions account for approximately 90% of surface water use and may result in practically no flow during the summer months (Levings et al. 1998).

The Rio Grande aquifer system covers a 70,000-mi^2 area of southern Colorado, central New Mexico, and western Texas. It consists of a network of hydrologically interconnected aquifers in basin-fill deposits located along the valleys of the Rio Grande and nearby rivers. These aquifers are generally composed of unconsolidated sediment deposits present in intermountain basins. Groundwater recharge primarily originates as precipitation in the mountainous areas that surround the basins, while most of the precipitation that falls in the valleys is lost to evaporation and transpiration. Potential evaporation may exceed 100 inches per year, while precipitation is frequently less than 8 inches per year (Levings et al. 1998).

Most groundwater withdrawal occurs as discharge from pumping wells, of which about 90% is used for irrigation of commercial crops. Most cities and communities in the area, such as Albuquerque, Las Cruces, and Santa Fe, New Mexico, rely on groundwater for municipal use. Groundwater withdrawals in closed basins have caused long-term water level declines, while withdrawals from wells located near the Rio Grande, or its perennial tributaries, generally do not cause long-term water level declines in the aquifer.

Missouri Hydrologic Region

This hydrologic region covers the largest geographic area of the nine regions, including much of Montana, Wyoming, northeastern Colorado, North Dakota, South Dakota, and Nebraska. This region represents the eastern front of the Rocky Mountains stretching to the Great Plains, most of which is drained by the Missouri and Platte rivers and their tributaries.

Surface water resources are dominated by the major rivers and their tributaries. Precipitation is generally sparse in the summer and fall months, and surface water flow is generally dependent on snowmelt in the mountainous areas. Rivers flow mainly from late spring to early fall and can be dry in some parts of the region during the winter months. Surface water is directly connected to groundwater through shallow alluvial aquifers that are found along all the major rivers and their tributaries. Groundwater baseflow supplies stream and river flow in the late summer and fall. Surface water is the main source of municipal and irrigation water in the Rocky Mountain region, and irrigation return flow is a major component of surface water flow.

Groundwater in Wyoming and western Montana is found both in the igneous rocks of the uplifts and the basins, although groundwater in the uplifts is generally not used. Groundwater is used extensively for irrigation, much of it becoming irrigation return water that flows into major streams and their tributaries. In addition to irrigation, groundwater is also used for municipal and domestic water supplies. Major aquifers in the Great Plains are the Ogallala Aquifer of eastern Wyoming, Nebraska, and Kansas, and the Dakota Aquifer of North and South Dakota. These aquifers are overdrawn and the water table has been declining for decades. Recharge comes only from stream infiltration and spring snowmelt.

Great Basin Hydrologic Region

The Great Basin of Nevada and Utah is an arid region located in the rainshadow of the Sierra Nevada Mountains. The Great Basin is characterized by northerly trending mountain ranges and intermountain valleys with closed drainage. Precipitation generally falls as rain and snowfall in the mountains. Streams flowing down from the mountains carry water to the basins, which infiltrates into the alluvial sediments and provides the only substantial recharge to groundwater in the basins. Surface water flow in the basins is derived almost entirely from the mountain streams.

Apart from major rivers (e.g., the Humbolt and Truckee rivers), surface water flow in the basins of Utah and Nevada is intermittent along the mountain fronts and ephemeral in the basins themselves. Surface water flow in the mountainous areas is limited mainly to late spring snowmelt in the higher areas of the ranges. Agricultural diversions of major streams exiting the mountains are common, and major rivers are used extensively for irrigation. Surface water flow in northern Nevada has been affected by groundwater pumping from mining areas into the rivers. The Humboldt River, from Battle Mountain to Winnemucca, Nevada, is dominated by mine discharge.

Groundwater is found in the alluvium of the basins and in the deeper rocks that underlie the alluvial basins. Shallow groundwater in the alluvium of the basins is the main source of water for domestic consumption, irrigation, and power plant cooling. Some areas of the Great Basin, particularly in northern Nevada, have geothermal reservoirs that underlie the shallow groundwater reservoirs. These geothermal waters have been tapped, often inadvertently, by open pit mining and dewatering of areas used for gold mining. The Great Basin contains many of the largest groundwater reservoirs in the United States. These reservoirs are largely untapped at present, but major urban areas like Las Vegas are actively pursuing their development.

Arkansas-White-Red Hydrologic Region

This hydrologic region occupies the drainage of the Arkansas, Canadian, and Red River basins above the points of the highest backwater effect of the Mississippi River. It includes all of Oklahoma and parts of Colorado, New Mexico, Texas, Kansas, Missouri, and Louisiana. Only a relatively small proportion of public lands are found in this region, primarily concentrated near the headwaters of the Arkansas River in central Colorado and near the headwaters of the Canadian River in northeastern New Mexico.

Surface waters generally originate from precipitation falling in the eastern Rocky Mountains. Precipitation is relatively sparse in the summer and fall months, and surface water flow is typically dependent on snowmelt in the mountainous areas. Surface water resources are used extensively for agricultural irrigation.

Groundwater resources, which are extensive in this region, and consist primarily of the Ogallala Aquifer and alluvial aquifers associated with the river valleys. The Ogallala Aquifer underlies much of this region, and water withdrawals are used almost exclusively for irrigation (Robson and Banta 1995).

Water Quality

Water quality is defined in relation to its specified and/or beneficial uses, such as human consumption, irrigation, fisheries, livestock, industry, or recreation. The quality of surface water is determined by interactions with soil, transported solids (organics and sediments), rocks, groundwater, and the atmosphere. The Clean Water Act established the basic structure for regulating discharges of pollutants into the waters of the U.S., and is responsible for setting water quality standards for all contaminants in surface waters. Section 313 of the Clean Water Act requires all federal agencies to comply with state water quality standards "...to the same extent as any nongovernmental entity." Thus, the BLM has a responsibility to fulfill its obligations under the Clean Water Act and Safe Drinking Water Act, to maintain waters that meet or surpass designated beneficial uses, to restore impaired water resources in support of their designated beneficial uses, and to provide water for public consumption and use (USEPA 2003e).

Section 303(d) of the Clean Water Act requires that water bodies violating state water quality standards and failing to protect beneficial uses be identified and placed on a 303(d) list (USEPA 2003e). The delisting of 303(d) listed streams is a priority of the BLM.

Nonpoint source pollution, the largest source of water quality problems, comes from diffuse or scattered sources rather than from an outlet, such as a pipe that constitutes a point source. Sediment is a nonpoint source of pollution that results from activities such as livestock grazing and timber harvest. Erosion and delivery of eroded soil to streams is the primary nonpoint source pollution problem of concern to the BLM (USDI BLM 1980).

The most important factors affecting water quality include sediments, microbes, pesticides, nutrients, metals, and radionuclides (Nash 1993). Sedimentation and nutrient loading affect surface waters, while agricultural runoff and industrial wastes can also leach into groundwater. Surface water quality is also affected by solar loading and shade producing vegetation that affect water temperature, flow, total suspended solids (TSS), total dissolved solids (TDS), turbidity, changes in dissolved oxygen, salinity, and acidity.

The susceptibility of aquifers to groundwater contamination relates to geology, depth to groundwater, infiltration rates, and solubility of contaminants. Deep aquifers are often too deep to be affected by surface alteration or shallow waste disposal. However, shallow aquifers may be directly affected by surface alternation and by waste and wastewater disposal. Shallow, unconfined aquifers with rapid recharge rates are generally the most vulnerable to contamination because of the rapid infiltration of groundwater from the surface to the water table.

Water quality data for the surface and groundwater resources of the western states are available from the USGS National Water Information System (NWIS) database (USGS 2002b), the USGS National Water

Quality Assessment (NAWQA) Program (USGS 2002c), the USEPA's Index of Watershed Indicators (USEPA 1999b), the USEPA's National Water Quality Inventory (USEPA 2000a), the USGS Groundwater Atlas of the United States (USGS 2000), and from state water quality databases. These sources have been used to develop a general assessment of water quality in the hydrologic regions of the western states (including Alaska), where the BLM has substantial land management responsibility. Data from the USEPA's Index of Watershed Indicators characterizes the condition and vulnerability of each of the 2,262 subbasins in the U.S. (Map 3-6). Information on general groundwater quality (based on concentration of TDS) was compiled from the USEPA's National Water Quality Inventory (USEPA 2000a; Map 3-7).

Alaska Hydrologic Region

Surface and groundwater resources in Alaska are of relatively good quality. The lack of industrial and agricultural development reduces the risk of contamination of water resources. Human activities, such as mining, oil drilling, and waste disposal in small villages contribute to localized surface and groundwater pollution. Oil drilling adds petrochemicals to both surface water and groundwater, and waste disposal adds nitrates and colliform bacteria. Public lands have localized surface water and groundwater contamination from oil drilling.

Pacific Northwest Hydrologic Region

Surface water quality has been degraded in the agricultural areas of eastern Washington and Oregon and in southern Idaho by contamination resulting from agricultural and grazing practices. Elevated levels of nitrates, phosphates, and other nutrients are found in these waters. In Montana, agricultural practices in the Bitterroot Valley have added nutrients to surface water. Fish farming has also contributed to elevated nutrient levels in these streams and rivers of Washington. Irrigation return waters in the Snake River Basin are contributing nutrients and pesticides to surface waters (Clark et al. 1998). Herbicide use results in elevated levels of these chemicals in surface waters during the growing season; however, these levels typically decline after the growing season.

Groundwater is generally of good quality for most uses across the Pacific Northwest. Rivers and streams with lower water quality are primarily the result of thermal modifications, pathogens, habitat alteration, and concentrated agricultural activities in areas such as the Willamette Valley and the Columbia Plateau (Wentz et al. 1998; Williamson et al. 1998; USEPA 2000a). Elevated levels of nitrates and pesticides have been detected in the groundwater in the Snake River Basin and the Columbia Plateau.

California Hydrologic Region

Surface water resources in California show elevated concentrations of TDS from high salinity, particularly in the southern portion of the region. Groundwater and surface water diversions are used for agricultural irrigation in California. Because of the arid nature of the climate, much of this irrigation water evaporates, leading to irrigation return waters that flow back into streams with elevated levels of salt, nutrients, and pesticides. In the agricultural areas of the Central Valley of California (San Joaquin and Sacramento River basins), nutrient loadings to streams and accumulation of pesticides in aquatic organisms and streambed sediments are a problem (Dubrovsky et al. 1998; Domagalski et al. 2000). Nitrate concentrations in streams generally meet USEPA drinking water standards, but at levels that can pose a problem for aquatic life.

Groundwater in southern California has naturally high concentrations of TDS from the presence of evaporite beds in the sedimentary rocks that underlie the desert areas. In agricultural areas, extensive fertilizer use, combined with heavy irrigation to overcome the high evaporation rates, have resulted in elevated concentrations of nitrates in shallow groundwater reservoirs. Pesticides are present in shallow groundwater reservoirs, but at concentrations generally below USEPA drinking water standards. In agricultural areas, groundwater is used for irrigation, leading to substantial declines in shallow groundwater tables and contamination of groundwater resources by agricultural practices. In the desert areas administered by the BLM, groundwater is generally not affected by pesticides. The low recharge rate for groundwater in these areas means that any application of herbicides is unlikely to enter and affect groundwater resources.

Upper Colorado Hydrologic Region

In this hydrologic region, surface waters generally flow out of the southern Rocky Mountains and work their way to major rivers. Water quality in the southern Rocky Mountains is generally good, except in historic mining areas. As the surface waters pass through the Colorado Plateau country, quality declines due to agricultural practices, evaporation, a change in the

nature of the bedrock, and urban wastewater disposal practices (Spahr et al. 2000). Concentrations of nutrients and pesticides increase as the waters pass through this area. Groundwater quality in this region appears to be influenced mainly by the nature of the bedrock. In areas of sedimentary rock, concentrations of TDS, along with radon, uranium, and metals, can be high. Mesozoic rocks in this region may host uranium, selenium, evaporite, and copper deposits. In areas of the Colorado Plateau administered by the BLM, grazing and mining are the main activities, often leading to local groundwater contamination from metals, especially the uranium-rich areas of the Colorado Plateau.

Lower Colorado Hydrologic Region

High surface water temperatures in this hydrologic region affect water quality. Total dissolved solids concentrations can be elevated, especially along major rivers with extensive agriculture in their river valleys, such as the Salt and Gila rivers of Arizona. Agricultural land use practices and mining have been the major contributors to surface water degradation in this region. Public lands in this region are used mainly for grazing and mining, resulting in localized impacts to surface waters. These impacts include increases in turbidity, sedimentation, salinity, and possible chemical contamination. High erosion rates can be expected wherever there is a large percentage of exposed soil, a very common result of grazing by domestic animals in this region (Bogan et al. 2003).

Groundwater quality in this region is dependent on the rocks that host the groundwater reservoir. Shallow groundwater reservoirs are mainly in alluvium or Late Tertiary sedimentary beds dominated by lakebeds and evaporites, causing saline groundwater with elevated concentrations of TDS. In mining districts, concentrations of metals are elevated in the groundwater, and in areas of extensive grazing, shallow alluvial groundwater may have elevated concentrations of nitrates and bacteria. Deep groundwater reservoirs are usually contained in carbonate rocks, leading to groundwater of good quality and low concentrations of TDS.

Rio Grande Hydrologic Region

Elevated levels of TDS associated with agriculture in the Rio Grande River valley can pose a problem for surface water quality. Agricultural practices along the Rio Grande River have also contributed nutrients and pesticides to surface waters (Levings et al. 1998). The upper reaches of the Rio Grande River in Colorado and the tributaries to the Rio Grande River in southern Colorado have shown elevated metal concentrations, primarily due to the Creede, Colorado, mining district.

Most of the groundwater resources utilized in the Rio Grande River basin are used for irrigation and livestock watering, although drinking water is also an important use. Nitrate concentrations may exceed USEPA standards, particularly in agricultural areas such as the San Luis and Rincon valleys. Pesticides have been detected in the groundwater in both agricultural and urban areas, but generally do not exceed USEPA standards. Volatile organic compounds (VOCs) may be present in shallow groundwater in urban areas such as Albuquerque and Santa Fe (Levings et al. 1998).

Missouri Hydrologic Region

In the high Rocky Mountains of this hydrologic region, surface water has low concentrations of dissolved solids and meets all aquatic and drinking water standards, except in areas of historic mining. As surface water leaves the mountains and enters the plains and valleys surrounding the mountainous area, the water quality changes. In Colorado, agricultural land use practices and urban wastewater disposal degrade the water quality by adding nutrients and pesticides (Dennehy et al. 1998). In Wyoming, dewatering from mining and petroleum extraction has resulted in localized increases in concentrations of dissolved solids and metals in surface waters. Grazing activities in the Great Plains affect surface water quality by contributing sediments and nutrients. Bacterial contamination of surface water by domestic livestock is considered a significant non-point source of water pollution (Bohn and Buckhouse 1985, George 1996). Areas of extensive agriculture often have elevated nutrients and pesticides in the surface water. Agricultural practices have contributed nutrients and pesticides to surface waters in basins along major rivers in this region.

Groundwater in this region is generally of good quality and low in TDS, except in areas of historic and present-day mining, where there are elevated concentrations of sulfate and metals in the groundwater. In areas of the Rocky Mountains administered by the BLM, mining is the principal source of groundwater contamination. A secondary source of contamination is the geology of the bedrock, where rocks rich in uranium and radon contribute to groundwater. This is particularly evident in Wyoming and in the South Platte River basin of Colorado (Dennehy et al. 1998). Shallow alluvial groundwater in agricultural areas has elevated concentrations of nutrients and pesticides. Shallow

groundwater along the Colorado Front Range and in large urban areas of the Rocky Mountains shows local evidence of contamination by wastewater, petroleum by-products, and nutrients and/or pesticides used on lawns and golf courses. In the Great Plains, groundwater has nitrate concentrations that often exceed the USEPA limit of 10 parts per million (ppm) and also has elevated concentrations of pesticides.

Great Basin Hydrologic Region

Water quality in the rivers and streams of this hydrologic region has been affected by agricultural land use along the major rivers, urban waste disposal practices, the chemical composition of rocks in the river basins, and past mining activity. Public lands in the Great Basin generally exclude urban and agricultural areas, but include most of the areas of past mining. Agricultural practices have contributed nutrients and pesticides to surface waters in basins along major rivers. Urban areas, such as Reno, Las Vegas, and Salt Lake City, have added nutrients and synthetic organic compounds to surface waters as well. Past mining activity has added metals to surface waters in localized areas throughout the Great Basin. The chemical makeup of near-surface rocks has contributed arsenic, uranium, and radon to surface waters (Bevans et al. 1998).

Groundwater quality in the Great Basin is determined mainly by the chemistry of the rocks that host the groundwater reservoir. Groundwater in reservoirs made of carbonate rocks and sandstones has relatively low concentrations of TDS and is of good quality. Groundwater in the central parts of basins with playa lakes, and in areas with evaporite beds, generally has elevated concentrations of salts and TDS. Groundwater in mining areas often has high localized concentrations of mercury, arsenic, and other metals. In areas of extensive agriculture, shallow alluvial aquifers are often contaminated with nitrates and pesticides.

Arkansas-White-Red Hydrologic Region

Surface water quality is typically moderate in this hydrologic region, and poor in areas with extensive agricultural or livestock production. The upper reaches of the Arkansas River, where most public lands are located, rely primarily on spring snowmelt for recharge and are generally of better water quality than other portions of the region.

Groundwater quality is relatively good in this region. The TDS concentration of water in the aquifers in eastern Colorado and eastern New Mexico is generally less than 500 milligrams per liter (mg/L), but may exceed 1,000 mg/L in small areas of Colorado. Concentrations less than 250 mg/L are found in northeastern Colorado and are the result of relatively high recharge rates in areas of sandy soil that contains few soluble minerals (Robson and Banta 1995).

Wetland and Riparian Areas

Wetlands are generally defined as areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support vegetation that is typically adapted for life in saturated soil (USDI BLM 1998b). Wetlands include bogs, marshes, shallows, muskegs, wet meadows, estuaries, and riparian areas. According to the 1987 Corps of Engineers Wetland Delineation Manual, an area must exhibit evidence of at least one positive wetland indicator from each of the following parameters to be defined as a wetland (Environmental Laboratory 1987):

- **Soils** - The substrate is predominately undrained hydric soil, or the soils posses characteristics that are associated with reducing soil conditions;
- **Hydrology** - The area is inundated either permanently or periodically at a mean water depth of less than 6.6 feet or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation; and
- **Vegetation** - The land supports predominately hydrophytes. Hydrophytes are macrophytic plants with the ability to grow in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content and depleted soil oxygen levels.

The BLM administers approximately 12.8 million acres of wetlands. Of these, approximately 12.6 million acres are found in Alaska (USDI BLM 2006d).

Riparian and wetland areas comprise approximately 9% of public lands (USDI BLM 2006c). The benefits of these vital areas, however, far exceed their relatively small acreage. The functions of wetland and riparian areas include water purification, stream shading, flood attenuation, shoreline stabilization, groundwater recharge, and habitat for aquatic, semiaquatic, and terrestrial plants and animals (USEPA 2001b).

The BLM has surveyed 89% of the wetland acreage in the lower 48 states. Only a small fraction of the wetlands in Alaska have been surveyed due to their pristine nature and lack of immediate development pressure. Sixty-seven percent of wetlands in the lower 48 states evaluated were judged to be functioning properly (USDI BLM 2006d). Ninety-eight percent of Alaska wetlands are assumed to be functioning properly. The remaining Alaska wetlands have been placed in the "Unknown" category because some questions have been raised about development impacts.

The BLM defines properly functioning wetlands as those that: 1) support adequate vegetation, landform, or debris to dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality; 2) filter sediment and aid floodplain development; 3) improve floodwater retention and groundwater recharge; 4) develop root masses that stabilize islands and shoreline features against cutting action; 5) restrict water percolation; 6) develop diverse ponding characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterbird breeding, and other uses; and 7) support greater biodiversity (Prichard et al. 2003). This assessment does not take into consideration the habitat value of the wetland to fish and wildlife.

About 20% of wetlands are considered to be functional, but at risk, and 2% are non-functional, in terms of their ability to dissipate energy associated with high-flow events (USDI BLM 2006d). Public lands with poorly functioning wetlands tend to be located in the southwestern U.S.

Riparian areas, according to the BLM, are green zones along flowing-water features such as rivers, streams, and creeks (Gebhardt et al. 1990). These areas exclude streams where water flows for only brief periods during storm runoff events (ephemeral streams). The BLM administers approximately 143,000 miles of riparian habitat in the treatment area. Of this, approximately 107,565 miles are found in Alaska (USDI BLM 2006d).

It is estimated by the BLM that 46% of surveyed riparian areas in the lower 48 states and 100% of riparian areas in Alaska are properly functioning in terms of having adequate vegetation, landform, or large woody debris present to dissipate stream energy associated with high waterflows (USDI BLM 2006c). Eight percent of riparian areas in the lower 48 states are considered non-functional, and 38% are functioning but at risk (USDI BLM 2006c). Poorest functioning riparian areas are found in the southwest and Montana, while most riparian areas in Alaska, Colorado, and Utah function properly.

Vegetation

The composition and distribution of plant communities in the western U.S. have been influenced by many factors, including climate, drought, insects, diseases, wind, domestic livestock grazing, cultivation, browsing by wildlife, and fire (Gruell 1983). Other activities that have a direct and/or indirect effect on plant communities include logging, minerals extraction and reclamation activities, recreational activities, and ROW development including road construction and maintenance. In addition, competition with non-native invasive plant species has resulted in the loss of native plant communities in portions of the western states.

Before European settlement, naturally occurring fire was an important influence on the landscape of the West, and plant communities are adapted to the occasional intense fires that burned over the landscape (Gruell 1983). The exclusion of fire following European settlement has caused significant changes in plant species composition in the western U.S., especially in areas adapted to fire (Swetnam 1990). Where fire-adapted communities previously limited the expansion of juniper, sagebrush, and other less fire-tolerant species, exclusion of fire has resulted in invasion of these species into the surrounding ecosystems (Gruell 1983). The circumstance has also contributed to accumulation of hazardous fuels.

Ecological Processes that Underlie the Effects of Fire on Flora

The following section presents an overview of ecological principals related to the effects of fire on vegetation, followed by a discussion of the fire ecology and vegetation in each ecoregion. The following documents were the source of information provided in this assessment: *Final EIS Vegetation Treatment on BLM Lands in Thirteen Western States* (USDI BLM 1991a); *Wildland Fire in Ecosystems Effects of Fire on Flora* (USDA Forest Service 2000b); *Proceedings of the Invasive Species Workshop: The Role of Fire in the Control and Spread of Invasive Species* (Tall Timbers Research Station 2001); and *Fire as a Tool for Controlling Nonnative Invasive Plants* (Rice 2004). The reader is encouraged to consult these documents, and the references cited therein, for a more detailed

assessment of fire-vegetation relationships; website links to several of these documents are provided in the References section of the PER.

Fire Recurrence

Fire has shaped plant communities for as long as vegetation and lightning have existed on earth (Pyne 1982). Approximately 8 million lightning strikes per day occur globally that can start fires. During the past 20,000 years, humans have also been a major source of ignition, and the intentional burning of vegetation by Native Americans has occurred for several centuries (Gruell 1985, Denevan 1991).

Historically, fire has occurred over large areas covering more than half of the U.S. at intervals of 1 to 12 years, and at longer intervals over the remainder of the country (Frost 1998). The frequency of historical fire varied widely depending on climate. Fire return intervals in the western U.S. typically ranged from 2 to 5 years in ecosystems that supported abundant cured or dead fine fuels such as ponderosa pine and oak savanna in the Southwest; 5 to 35 years for dry site conifers, shrublands such as California chaparral, and most grasslands; 35 to 200 years for mesic site western conifers; 200 to 500 years for some wetter site conifers; and 500 to 1,000 years for extremely cold or wet ecosystems, such as alpine tundra and Pacific Northwest coastal spruce-hemlock forests.

Historically, fires have occurred at irregular intervals, largely determined by climate (Johnson and Larsen 1991, Swetnam 1993). However, temperature was the most important influence on fire frequency over periods of decades to centuries. In both cases, fuel moisture content was probably the fuel property most influenced by climatic trends in precipitation and temperature.

Biodiversity

Biodiversity is the variety of life and associated ecological processes that occur in an area. Fire regime, which is defined as the nature of fire occurring over long periods and the prominent immediate effects of fire that generally characterize an ecosystem, influences biodiversity in various ways (Duchesne 1994). The official definition of fire regime is the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects, in a given area or ecosystem (National Wildfire Coordinating Group 2007). In forest ecosystems, understory fire (i.e., fires that tend to occur in the understory and are nonlethal to the dominant vegetation) regimes have the greatest influence on biodiversity within plant communities because the understory vegetation is more affected by fire than the overstory. Stand-replacement fire (i.e., fire kills aboveground parts of the dominant vegetation and changes the aboveground structure substantially) regimes influence biodiversity across the landscape by affecting the size, shape, and distribution of vegetation patches. Mixed fire (i.e., causes selective mortality in dominant vegetation or varies between understory fires and stand-replacement fires) regimes have a substantial effect on biodiversity within plant communities. Fire frequency and timing largely determine biodiversity in grassland systems (Brown and Smith 2000).

Biodiversity can be increased by fire and reduced by eliminating fire. Variability of fire regimes in time and space creates the most diverse complexes of species. Thus, landscapes having fires with high variability in timing, intensity, pattern, and frequency tend to have the greatest diversity in ecosystem components (Swanson et al. 1990). However, biodiversity can be reduced when fires occur much more frequently than they did under the historical fire regime.

Plant Response to Fire

Many species depend on fire to continue their existence. Many species have adaptive traits that allow species to survive fire. Thick bark, fire resistant foliage, and adventitious buds allow plants to survive low to moderate intensity fires of short duration, while traits such as fire-stimulated germination and belowground sprouting parts allow plants to survive high intensity fires (Brown and Smith 2000). Fire severity and intensity have a large influence on the composition and structure of the initial plant community following fire.

As a general rule, burned areas tend to return to the same flora that was there before fire (Lyon and Stickney 1976, Christensen 1985). However, fires of high severity create opportunities for new plants to establish from off-site seed. Large, high severity burns can be slow to recover, depending on available seed sources. Fires of low severity are followed by a strong sprouting response, except where annuals are the dominant vegetation.

The timing of fire, including seasonality and frequency, is important in determining fire severity and species survival. Seasonal timing of fire affects reproduction of herbaceous plants and shrubs. For example, spring and summer fires may produce abundant postfire flowering, while fall fires may produce little. Fire frequency is especially important for short fire-return interval

species. Frequent fire regimes that allow control of shrubs are important for maintaining grassland ecosystems (Brown and Smith 2000). Many rare and threatened plant species depend on short-return fire intervals to survive (Greenlee 1997).

Community and Landscape Responses to Fire

Species diversity within a plant community depends on species composition, the adaptive traits of plants, the timing of fire, and the nature of fire as it moves through the community. The spatial arrangement of fuels and individual plants can be important to survival, particularly where fuels are unevenly distributed. Concentrations of live or dead fuels can generate high fire intensities and severities on relatively small sites, which can enhance or reduce diversity depending on the community. For example, in a Douglas-fir forest, localized fuel concentrations may result in fire-created gaps or holes in the canopy, creating structural diversity and stimulating understory vegetation, a typical response to fire in a mixed fire regime. However, in a ponderosa pine forest, excessive mortality to highly valued old growth trees might be a consequence (Brown and Smith 2000).

Ecosystems and plant communities are considered to be fire dependent when their continued existence depends on recurrent fire. Where fires occur regularly and frequently, such as in open pine communities and Mediterranean shrublands, plant communities may remain stable for millennia (Chandler et al. 1983). Repeated fires in fire-dependent communities maintain a dynamic process that creates diversity across the landscape. If fire is excluded, however, biodiversity likely diminishes (Chang 1996).

Fires create patches on the landscape of different dominant vegetation and stand structure. Patches can vary in size and shape depending on the biophysical features of the landscape. Winds of variable speed and direction can cause fire to create a variety of burn shapes. Terrain and landforms primarily determine patch characteristics in heavily dissected landscapes. For example, historical fires were typically large (> 10,000 acres) in boreal forests on moderate terrain, but medium to large (100 to 10,000 acres) in conifer forests in mountainous terrain (Heinselman 1981, Brown and Smith 2000).

As time since the last fire increases, stands become similar and structural diversity is reduced. The likelihood of larger fires increases as the fire-free period becomes longer, resulting in larger fires and less patch diversity (Heinselman 1981, Bonnickson and Stone 1982, Swetnam 1993).

Ecological Processes

Fire is an ecological process that triggers other processes and associated conditions. Plant mortality, regeneration, and growth are obvious effects of fire. Secondary effects include plant succession, decomposition of dead material, and accumulation of fuel needed for a fire to start.

Successional Pathways

Succession is viewed as a dynamic process that can move in different directions under the influence of periodic disturbance and may never reach a stable end point (Christensen 1988). Successional classes (e.g., mature forest) are described by vegetation type and structural stage. Time is a key element in understanding succession (Wright and Heinselman 1973). Some grassland plant communities regain their former composition and structure within 1 to 2 years after a disturbance, while forest communities could take decades to centuries to recover to a mature condition. Fire severity influences the length of time until plant communities recover to their pre-burn state. Large, severe burns have a longer recovery time then less severe fires. Periodic fires at short intervals can prevent the development of later successional vegetation stages, and can sometimes alter successional pathways if frequent fires eliminate propagules of later successional species, as in the case of frequent fires in sagebrush sites dominated by downy brome.

Decomposition

Fire, insects, and pathogens are responsible for the decomposition of dead organic matter and the recycling of nutrients (Olson 1963, Stoszek 1988). Burning directly recycles the carbon found in living and dead vegetation. The relative importance of fire and biological decomposition depends on site and climate (Harvey 1994). In cold and dry environments biological decay is limited, which allows accumulation of plant debris. Fire plays a major role in recycling organic matter in these environments. Without fire, nutrients are tied up in dead woody vegetation. In forests, increased tree density results in increased competition and moisture stress, and increased likelihood of mortality from insects and diseases. Increased mortality leads to increased dead fuels and increased fire. In grassland ecosystems where both fire and grazing are excluded, thatch or dead herbaceous litter accumulates, reducing

plant productivity and plant species richness (Wright and Bailey 1982). Fire can help control encroaching shrubs and trees; increase productivity, utilization of coarse grasses, and availability of forage; and improve habitat for wildlife.

Fuel Accumulation

Fuel accumulation is a term that is often used to indicate an increasing potential for fire to start, spread, and intensify as the time since the last fire increases. Fuel accumulation and associated fire potential depend on fuel quantity as well as other important fuel properties such as compactness and continuity (vertical and horizontal). Generally, the greatest amount of fuel accumulation is on highly productive sites in grassland, shrubland, and forest ecosystems (Brown and See 1981, Wright and Bailey 1982). In forest ecosystems, much of the dead fuel exists as coarse woody debris.

Fuel continuity is important because it partially controls where a fire can go and how fast it travels. In grasslands and open shrublands, heavily grazed areas and areas of low productivity form discontinuous fuels that limit the spread of fire and can be a critical obstacle to use of prescribed fire. In forests, existence of ladder fuels from understory vegetation allows surface fires to reach into the crown canopy. If the canopy is mostly closed, crown fire can readily develop under adequate wind speeds. Open canopies do not support crown fires. Increased fuel continuity can account for changes in fire severity from understory to stand replacement.

Live and dead fuels, as well as small and large diameter fuels, can follow different patterns of accumulation in forests. Typically, live herbaceous and shrub fuels increase following fire during early stages of stand development. Then, as tree canopies close, fuel quantities tend to decrease on mesic sites (Habeck 1976, Lyon and Stickney 1976). However, the decrease in fuels may not occur where understories contain shade tolerant species, which tend to have more foliar biomass than shade intolerant species due to their longer needle retention and higher crown densities (Brown 1978). Because of their shade tolerance, they can fill in crown canopy gaps and develop into understory ladder fuels.

On many grasslands, grazing eliminates some of the annual production, so fuel accumulation is minor. In the absence of grazing, fuel quantities depend primarily on annual production, which varies substantially by site potential and annual precipitation (Wright and Bailey 1982). In shrub and shrub/grass ecosystems, young communities generally have a low dead-to-live ratio. Flammability depends largely on grass and sedge fuels. As shrubs become senescent or undergo mortality, dead stemwood accumulates, which significantly increases potential flammability.

Human Influences

People are part of ecosystems and as such have exerted a major, far-reaching influence on fire across the landscape. Burning by Native Americans was common throughout the United States, although its extent varied considerably, depending on locale and population movements (Pyne 1982, Boyd 1999).

Efforts to suppress fires were modest at first, relying on wet blankets and buckets of water around dwellings and campsites. Suppression capabilities now rely on sophisticated communications, rapid attack, specialized equipment, and many fire fighters. Fire protection has reduced the extent of fire and increased fire intervals. Then, more protection is needed to keep burned acreage down.

Shifting Fire Regimes

Across most of the U.S., fire regimes have shifted from what they were historically. In a comprehensive assessment of burning in the contiguous United States, Leenhouts (1998) estimated that approximately 10 times more area must be burned than at present to restore historical fire regimes to nonurban and nonagricultural lands. The greatest departure from historical fire regimes is in the Rocky Mountains, where only a small fraction of the pre-1900 annual average fire acreage is being burned today (Barrett et al. 1997). Extensive grazing by domestic stock that reduces fuels, and fragmentation by agriculture and urbanization, have also contributed to shifting fire regimes. Lengthened fire return intervals have resulted in changes to vegetation and fuels by increasing wildfire severity and decreasing species and structural diversity. A recent comparison of historical and current fire regimes in the Interior Columbia River Basin showed that fires have become more severe over 24% of the area (Morgan et al. 1998).

Forests and Woodlands

Changes in forest composition and structure due to shifting fire regimes have been widely documented. Generally, shade-intolerant species are being replaced with shade-tolerant species. Stand densities are increasing with the development of multiple layer canopies. Outbreaks of insects and occurrence of root diseases appear to be worsening (Stewart 1988). The

greatest impacts have occurred in the understory fire regime types typified by ponderosa pine and longleaf pine ecosystems. Although these two ecosystems experience widely different climates, they share the same end results of fire exclusion, which is made worse in some locations by selective harvesting of old growth trees. Where fire regimes have shifted, growth and vigor of trees are reduced, insect and disease mortality is increased, and understory fuel loadings and continuity are increased so that wildfires tend to be of high intensity, killing most or all of the overstory. Diversity of understory herbs and shrubs is decreased.

Under mixed fire regimes, there is considerably less nonlethal understory fire than in the past (Brown et al. 1994). The mixed fire regime is shifting toward a stand-replacement fire regime that favors more shade tolerant species and less landscape diversity. In stand-replacement fire regimes, fire intervals have generally lengthened; however, the effects of this change vary widely depending largely on presettlement fire return intervals and accessibility for fire suppression efforts. For example, in a lodgepole pine/subalpine fir forest in Idaho, presettlement stand-replacement fire was 1.5 times more prevalent than during the recent period (Brown et al. 1994). In the same forest type in Yellowstone National Park, however, the area burned probably has not changed substantially from presettlement to recent periods (Romme and Despain 1989).

The age distribution of marginally commercial and noncommercial forests, such as those in wilderness areas and parks, is shifting to an abundance of older stands (Brown and Arno 1991). Succession is increasing the shade tolerant component of stands, making a major species shift likely if fire continues to be excluded. In the case of aspen, more than half of the aspen forest type has been lost, much of it due to successional replacement by conifers (Bartos et al. 1983; Bartos 1998). Fire protection policies have resulted in the fire cycle in aspen shifting from about 100 years to 11,000 years.

Grasslands and Shrublands

Grassland fire regimes have shifted dramatically from the presettlement period. Many ecologists consider the reduced frequency and extent of fires on rangelands due to fire protection to be among the most pervasive influences in the United States by non-indigenous peoples (Pieper 1994). The shift to woody plant domination has been substantial during the past hundred years. Grazing and possibly climate changes have acted with reduced fire to give a competitive advantage to woody plant species. Some woody plants, such as honey mesquite, become resistant to fire, develop fuel discontinuities, and reduce the spread of fire. In time, recovery following fire favors shrubs over perennial herbaceous species, which can alter the composition of ecosystems to the point that a return to the grassland type becomes nearly impossible or impractical (Archer 1994, Brown 1995).

Fire regimes have shifted to increased fire in the drier portions of the sagebrush-steppe ecosystem that occupies over 100 million acres in the western U.S. Fire frequency has increased in many areas due to invasion of downy brome, medusahead, and other introduced annuals that cure early and remain flammable during a long fire season. Increased fire frequency exerts strong selective pressure against many native plants. A contrasting situation exists for the more mesic mountain big sagebrush type, in which decreased fire frequency and encroachment by conifers is causing a reduction in herbaceous and shrub vegetation.

Managing Fire

Fire is an integral component of ecosystems that can affect all aspects of ecosystem management. Fire regimes have shifted as a result of human influences, and may continue to shift with clearly detrimental results in some ecosystems. Land managers need to know how to plan and carry out fire management strategies that successfully incorporate the ecological role of fire. Constraints on managing prescribed fire and smoke make it difficult to achieve resource goals, while protection against wildland fires allows development of undesirable ecological consequences (Brown and Arno 1991).

Historical Range of Variability

The historical range of variability (also called natural range of variability) in ecosystem components can be used to help set desired future conditions and fire management objectives. It can serve as a basis for designing disturbance prescriptions at varying spatial scales and help establish reference points for evaluating ecosystem management (Morgan et al. 1994). Historical fire regimes of forest ecosystems are often characterized by determining age distribution and aerial extent of seral classes across a large landscape, and dating fire scars to determine fire return intervals. A strong argument can be made that knowledge of historical fire should be used as a guide for understanding landscape patterns, conditions, and dynamics, but not necessarily for

creating historical landscapes. Knowledge of historical variability provides a basis for bringing the range of existing conditions in a landscape within the historical range (Swanson et al. 1993).

Restoration of Fire

The need for restoration is most evident in high fire frequency regimes, such as understory fire regime types and some grasslands and shrublands, where fire has been excluded for several times longer than the average fire return interval. Although considerable knowledge supports the need for restoration of fire into wildland ecosystems, constraints and obstacles confront land managers (Brown and Arno 1991, Mutch 1994). Limited funding, air quality restrictions, concerns over escape fire, and inadequate public support can pose difficulties. Some breakthroughs in managing emissions and obtaining support have provided more latitude for prescribed fire programs (Mutch and Cook 1996).

Restoration of fire in grasslands, shrublands, and savannas requires careful consideration of seasonal timing and frequency to assure that prescribed fires will spread at appropriate severities. Once woody plants have encroached to a point of dominating a site, it becomes difficult to get fire to spread with sufficient heat to kill aboveground stems, such as oak in savannas (Huffman and Blanchard 1991) and juniper in sagebrush/grass communities. Perhaps the greatest obstacle to success lies in areas that have successionally lost the native mix of species and lack sufficient grass fuel to carry fire. In these areas, seeding of native species following fire may be necessary to restore a semblance of former plant species composition. Where conifers such as pinyon-juniper and inland Douglas-fir invade grasslands, successful spread of surface fire may require fuel enhancement work, such as cutting numerous trees to create adequate surface fuels (Gruell et al. 1986). Otherwise, crown fire may be required, which will necessitate a more flammable, narrow fire prescription that can limit burning opportunities.

Fire Ecology and Vegetation by Ecoregion

Vegetation within the treatment area has been classified into 14 subclasses that are consistent with the National Vegetation Classification Standard (Federal Geographic Data Committee 1997; Table 3-4). The subclasses differentiate vegetation on the basis of growth form (tree, shrub, or herb), life history strategy (evergreen or deciduous, annual or perennial), and percent of canopy closure (forest or woodland) or hydrologic influences. The following sections discuss important vegetation subclasses for each ecoregion and their fire ecology.

Tundra Ecoregion

Located at high latitudes in northern and western Alaska, plant communities in the Tundra Ecoregion are adapted to withstand an extremely short growing season, continuous permafrost, and limited rooting depths. Slow-growing dwarf shrubs, grasses and sedges, and cryptogams (lichens) are the dominant vegetation types in this region. Approximately 39 million acres of public lands occur within this ecoregion.

Perennial graminoid communities are found on over 13 million acres (Map 3-8). Along Alaska's coastal regions to the north, west, and southwest, cottongrass-tussock communities are the most widespread plant systems. Cottongrass occurs as the dominant species in extensive patches in flat, poorly drained areas, and is associated with other sedges, dwarf shrubs, lichens, mosses, dwarf birch, Labrador tea, and cinquefoil. Similar plant communities are also found at low elevations in the mountainous North Slope and Alaska Peninsula regions.

Deciduous shrublands (both dwarf and non-dwarf) are found in many of the same areas as perennial graminoid communities, as well as higher elevation alpine areas. Deciduous dwarf-shrubland occurs on over 10 million acres and is characterized by shrubs that are less than 2 feet tall, a reduced stature that is attributable to extremely harsh growing conditions. Characteristic plant species include dwarf birch, willow, blueberry, and Labrador tea and other shrubs. A variety of forbs and graminoids are found in the understory, and lichen species may be an important component. At high elevations in mountainous areas, dwarf Arctic birch, crowberry, and dwarf blueberry are also common.

Deciduous shrubland species occur on over 6 million acres and are generally the same as those found in deciduous dwarf-shrublands, but are taller because of slightly better growing conditions. Willow, dwarf birch, alder, huckleberry, Labrador tea, and heath species are common. These communities may be successional to forest or woodland, or may be the climax vegetation where frozen and poorly drained permafrost soils limit tree growth. Stunted black spruce and other tree species are occasionally scattered throughout shrub communities.

In areas underlain by permafrost, nearly 3 million acres of sedge-dominated wet meadows, bogs, and wetlands

are scattered among the shrublands. Along major rivers and streams, riparian communities composed of alder, willows, and stunted stands of spruce and birch can be found. In shrublands, pure stands of stunted alder shrubs are found in wet drainages, at the head of streams, along river terraces, or on slopes. Some evergreen spruce woodlands, spruce hardwood forests composed of white spruce, paper birch, and alder, and black spruce forests also occur, in low amounts, in the Tundra Ecoregion.

Fire Ecology

In general, distribution of vegetation over the tundra biome is characterized by a patchy occurrence of dense vegetation, sparse vegetation, and bare ground offering an interrupted fuel bed (Payette et al. 1989). However, in the sedge tussock-mixed shrub tundra, the fuel layer, made up mostly of tussock cottongrass, is dense and continuous, leading to large, fast spreading fire conflagrations (Racine et al. 1987).

The transition zone between the upper limit of the boreal forest and the tundra, which has been distinguished as forest-tundra, is characterized by a fragmented cover of scattered forest stands of lichen-spruce and lichen-heath communities on well-drained sites. In Alaska, the forest-tundra is commonly termed taiga. The forest-tundra is further delineated into the forest subzone and shrub subzone (Payette et al. 1989; Sirois and Payette 1991). In both the forest-tundra and tundra, the ground vegetation is the primary carrier of fire. Lichens resemble dead tissue more than live tissue in their susceptibility to fire and often serve as the initial point of ignition. The low shrub component can provide a high percentage of fine, dry fuel with a low temperature of ignition (Auclair 1983).

Burning patterns of tundra ecosystems generally are characterized by moderate intensity surface fires that may kill all aboveground plant parts, but seldom destroy underground parts (Bliss and Wein 1972, Viereck and Schandelmeier 1980, Van Wagner 1983). Although the fire cycle may be as short as 100 years, it is usually much longer (Viereck and Schandelmeier 1980).

The tussocksedge tundra of Alaska may be a fire-dominated ecosystem, although the fire interval has yet to be determined (Racine et al. 1987). The long fire rotations in the tundra are probably related to the prevalence of cold, humid summers, saturated peat profiles, and the absence of continuous plant cover. These features serve to restrict fire spread over a large area (Payette et al. 1989).

Subarctic Ecoregion

Located within the central continental region of Alaska, the Subarctic Ecoregion primarily consists of evergreen forests and open lichen woodlands collectively known as the boreal forest, or taiga. The climate in this region is characterized by low precipitation (10 to 20 inches average annual precipitation), extreme ranges of temperature, low humidity, and high evaporation rates. However, as it is a diverse area, large portions of this region are semiarid as well. Approximately 43 million acres of public lands occur in this ecoregion.

Over 20 million acres of evergreen woodlands and mixed evergreen-deciduous woodlands can be found throughout this region. Within the lowland areas of interior central Alaska, evergreen woodlands are often composed of pure stands of black spruce, with an understory of willow, dwarf birch, crowberry, blueberry, lichens, and mosses. Within the mountainous regions of central and south-central Alaska, woodlands are also common, typically supporting a number of boreal tree species: white spruce, black spruce, tamarack, balsam poplar, paper birch, and aspen.

Deciduous shrubland occurs on 10 million acres, predominantly at higher elevations in the mountainous areas of this region. These shrublands are composed of a wide variety of low growing shrubs, herbs, grasses, and sedges, rooted in mosses and lichens. Mountain avens, low growing willows, dwarf birch, Labrador tea, blueberry, green alder, moss campion, and blackish oxytrope are all common species. Along riparian areas, deciduous tree species are prevalent. Paper birch, aspen, and balsam poplar are all found in these deciduous forest riparian communities. Extensive sphagnum bogs occur in old river terraces, ponds, and sloughs. These scattered wetlands are composed of sphagnum and other mosses, sedges, bog rosemary, Labrador tea, rose, birches, willow, bog cranberry, soapberry, and blueberry. About 2 million acres of forested communities also occur in the Subarctic Ecoregion. Mixed evergreen-deciduous forests, supporting many of the same species as woodlands, can be found in mountainous areas between elevations of about 1,000 and 3,000 feet (timberline). Spruce-hardwood forests, consisting of white spruce, birch, aspen, and poplar, with an undergrowth of mosses and berries, are common.

TABLE 3-4
Vegetation Classification System

Order	Class	Subclass
Tree dominated	Closed tree canopy	1. Evergreen forest
		2. Deciduous forest
		3. Mixed evergreen-deciduous forest
	Open tree canopy	4. Evergreen woodland
		5. Deciduous woodland
		6. Mixed evergreen-deciduous woodland
Shrub dominated	Shrubland	7. Evergreen shrubland
		8. Deciduous shrubland
	Dwarf-shrubland	9. Evergreen dwarf-shrubland
		10. Deciduous dwarf-shrubland
Herb dominated	Herbaceous vegetation	11. Perennial graminoid
		12. Annual graminoid or forb
		13. Perennial forb
		14. Riparian/wetland

Source: Developed by the BLM based on the Federal Geographic Data Committee Vegetation Subcommittee's National Vegetation Classification Standard (Federal Geographic Data Committee 1997).

Fire Ecology

Because of its structure, the black spruce forest in Alaska is highly flammable and burns readily. Most fires in black spruce associations are either crown fires or surface fires intense enough to kill the overstory trees (Viereck and Shandelmeier 1980). Because the base of most black spruce crowns is close to or in contact with the moss-lichen layer, surface fire readily spreads into the crowns of trees and ignites most of the black spruce and tamarack trees as it passes (Viereck and Shandelmeier 1980). Associated understory shrubs are top-killed and the moss-lichen layer is usually consumed. Small patches of exposed mineral soil are common, intermixed with less severely burned microsites (Foote 1983). Fires under extremely dry conditions may burn off this entire layer and completely expose the mineral soil, although this is not common. In less extreme conditions, the lichen-dominated black spruce forest burns while the moister and older feather moss dominated stands or deciduous mixed wood areas remain unburned (Foster 1983). In general, fire on black spruce sites is a common occurrence, and most stands burn before they are 100 years old (Foote 1983).

Because mature white spruce forests accumulate large amounts of organic matter consisting of feather mosses, woody fuels, flaky barks, and shrubs, they are highly susceptible to fire. Also, the crown and canopy structure (i.e., tree crowns extending nearly to the ground) is ideal for ignition and propagation of crown fires (Rowe and Scotter 1973, Van Wagner 1983). In the boreal forest, the fire regime is characterized by crown fires or severe surface fires with a return interval averaging 50 to 150 years. In Alaska, white spruce stands commonly are greater than 100 years old (Foote 1983).

In general, aspen stands are most flammable in the spring, late summer, and fall when they are leafless due to the drying effect of sun and wind on the leaf litter. Furthermore, in the fall the herbaceous plant and shrub component of the understory is dead and dried out, forming a continuous layer of loosely organized fine fuel. In general, flammability depends largely on the amount of herbaceous, shrub, and coniferous fuels present in the stand. Stands with a fair conifer component can burn when aspen leaves are still present.

Temperate Desert Ecoregion

The Temperate Desert Ecoregion is composed of arid lands in the rain shadow of the Pacific mountain ranges, including the Great Basin, Columbia Plateau, and Wyoming Basin. Plant communities, which are adapted to pronounced summer drought and cold winters, are composed primarily of xerophytic semidesert shrubs. Approximately 105 million acres of public lands occur in this ecoregion.

Evergreen shrublands in the form of sagebrush communities occur on nearly 74 million acres (Map 3-9). These shrublands typically consist of fairly dense to open vegetation, with shrubs that are 2 to 6 feet high and an understory of perennial and annual grasses and forbs (Cronquist et al. 1972). On the drier sites, shrub density is generally high, while on more mesic sites

individuals are more robust and widely spaced, with greater coverage of herbaceous species.

In the plains and tablelands of the Columbia River and Snake River plateaus and the Wyoming Basin, representative shrubs in sagebrush communities include big sagebrush, black sagebrush, low sagebrush, Mormon tea, and bitterbrush (Cronquist et al. 1972). Important perennial grasses include bluebunch and western wheatgrass, Sandberg bluegrass, Idaho fescue, and basin wildrye. Medusahead and downy brome are introduced annual grasses that have become abundant in these communities where the native herbaceous understory has been depleted, particularly in lower precipitation zones. They have an adaptive advantage over seedlings of most existing grass species in their ability to take advantage of limited moisture early, short lifespans, and prolific seed production. Where repeated fire or grazing have removed the native vegetation, these invasives, as well as invasive forbs, will dominate the site, taking advantage of what moisture exists and outcompeting the native vegetation. They then dry out and become fuel, burning very intensely and carrying fire into previously unburned areas, thus repeating and expanding the cycle.

In the Great Basin and northern Colorado Plateau, common shrubs in salt desert shrub communities are shadscale, fourwing saltbush, spiny hopsage, and greasewood. These communities occur from valley bottoms to mid-elevations in areas with shallow water tables and accumulated salts. Understory vegetation is generally sparse, with a large amount of bare soil or desert pavement exposed (MacMahon 1988). Species such as saltgrass, Indian ricegrass, squirreltail, fescues, and James' galleta may be found in this understory layer. Fires are generally absent due to the sparse fuels, and efforts to reestablish native plant communities are complicated by the dry conditions.

In the mountainous regions, sagebrush communities can be found scattered throughout the forested areas, and sagebrush communities dominate the foothills adjacent to the forested habitat. These higher elevation sagebrush communities are dominated by big sagebrush and other shrubs including antelope bitterbrush, mountain mahogany, and snowberry. The herbaceous component of these plant communities often contains Idaho fescue, bluebunch wheatgrass, various needlegrass and bluegrass species, and a variety of forbs.

Pinyon-juniper (evergreen) woodlands occur on nearly 14 million acres. These communities can be found in small areas in central Oregon, and at elevation zones above sagebrush communities throughout the rest of the ecoregion. Young pinyon-juniper trees are easily killed by fire, which historically limited their expansion into sagebrush communities (West and Van Pelt 1987). Stands of pinyon-juniper have established in many locations, and form dense canopies that cause the loss of understory plants. These closed-canopy pinyon-juniper stands generally do not have enough understory shrubs to carry a surface fire, and do not burn until conditions are met to carry a crown fire.

Deciduous shrublands typically occur at similar elevations as sagebrush, on arid, saline soils on nearly 3 million acres. Dropping leaves during times of drought enable plants such as greasewood, hopsage, catclaw acacia, and European smoketree to survive the harsh conditions. Many of these species are fairly tolerant of alkaline and saline conditions, and occur as lesser members of sagebrush and pinyon-juniper communities.

Other vegetation classes include the perennial bunchgrass grasslands of Oregon, Washington, and Idaho (6 million acres), and the evergreen forests that occur at elevations above woodlands (over 1 million acres). Dominant tree species in these forests include ponderosa pine and Douglas-fir. In a few areas, mountains are high enough to support subalpine fir and Engelmann spruce. Aspen commonly occurs in mountainous areas and is frequently mixed with young conifers.

Fire Ecology

During the era of Euroamerican settlement, fire frequencies initially increased in the Temperate Desert Ecoregion. Newspaper records between 1859 and 1890 report that settlers engaged in active fire suppression, including deliberate overgrazing of rangeland to reduce fuels. Woody species were favored by the reduction of grass and forb competition caused by overgrazing (Wright 1986). Grazing altered the role of fire in desert areas once dominated by grasses. The consequent reduction of major fires was followed by shrub invasion into desert grasslands. Early 1900s wildland management policies continued to promote historical fire suppression and rangeland use in desert landscapes. A new management strategy was initiated when managers recognized that continued shrub encroachment was associated with overgrazing and fire reduction (Leopold 1924, Komarek 1969). Shifts in land management resulted in reduced grazing, and increased fuels, and thus changed the fire dynamics. Currently, burning of thousands of acres is becoming more common, and fire has become a serious management

issue in some shrubland areas (Blaisdell et al. 1982; Bunting et al. 1987; Wilson et al. 1995a). Desert shrubland management traditionally focused on shrub eradication in favor of grasses. The objective was to improve forage for livestock and increase efficient management of range by increasing livestock and wildlife visibility. Fire, disking, herbicides, and heavy grazing were all commonly used. Often, the end result of this heavy range management was to decrease the amount of annual biomass and actually reduce the productivity of these ranges.

Historical accounts of sagebrush habitat are sketchy, but fires in big sagebrush were set both by lightning and humans. The many species and subspecies of sagebrush are quite susceptible to fire. Typical succession after fire would begin with grass/forb dominance, and eventually lead to sagebrush recovery in 30 or more years. In the late 1800s, overstocked free ranging cattle led to a depletion of perennial grasses and other palatable forage. The subsequent introduction and spread of downy brome in the early 1900s corresponds with increased fire frequency and the reduction of big sagebrush. This, in turn, increased erosion and further damaged perennial native grass and forb components (MacMahon 1992).

Since 1900, the cultivation and abandonment of marginal land, abusive grazing, and widespread recurrent prescribed burning of sagebrush has resulted in an imbalance between the numbers and sizes of shrubs, and associated native grasses and forbs (Blaisdell et al. 1982). Thus, much of the resource potential of the sagebrush range has been depleted. By 1936, 85% of sagebrush lands were considered depleted (Tisdale et al. 1969). Prescribed fire was used to remove shrubs and replace them with native perennial grass forage (Pechanec and Stewart 1944; Pechanec et al. 1954; Cornelius and Talbot 1955; Reynolds et al. 1968). This ecosystem readily burns, particularly where there is a contiguous understory of grasses. Habitat changes coincident with increased fire have included plant community composition changes (Blaisdell 1949, Hassan and West 1986), altered soil seed banks (Blank et al. 1995), and increased soil repellency (Salih et al. 1973). The absence of sagebrush is often an indicator of past burns (Humphrey 1974). Secondary consequences of wildfires in sagebrush can include range deterioration, flooding, erosion, lowered grazing capacity, and reduction in the amount and quality of wildlife habitat. Extensive research has focused on rangeland degradation (Young et al. 1979) and loss of productivity (Beetle 1960; Harniss et al. 1981).

Big sagebrush can gain dominance over the herbaceous layer in 5 to 30 years after a burn. The season in which a burn takes place affects the resulting species dominance (White and Currie 1983) and postfire sagebrush productivity (Mueggler and Blaisdell 1958). For example, silver sagebrush mortality is higher and regrowth is less after a dry fall burn (White and Currie 1983). After fires, sagebrush mortality is proportional to fuel reduction. Although many sagebrush species are readily killed by fire, at least three species (threetip sagebrush, silver sagebrush, and coastal sagebrush) are known to resprout (Tisdale and Hironaka 1981, Malanson and O'Leary 1985). Most sagebrush species reseed after fire, but may require fire intervals of up to 50 years to regain their dominance (Bunting et al. 1987). Frequent fires can cause conversion from sagebrush species to rabbitbrush, horsebrush, and snakeweed. Where downy brome occurs, the burn season is extended and wildfires are reported to consume more area per burn. Introduced downy brome can outcompete indigenous herbaceous species. Downy brome is undependable as forage because of its large fluctuations in yield from year to year. After two to three reburns, sagebrush sites can be converted to stable downy brome; fire return intervals of 5.5 years maintain downy brome dominance.

Downy brome is often accompanied by other invasive, noxious, and undesirable species. Together these pose a serious fire hazard, particularly following wet springs.

Planning prescribed fires in sagebrush should include specific objectives and consider many factors such as species and subspecies of sagebrush, soils, fuel loading, fuel moisture content, and windspeed (Salih et al. 1973; Britton and Ralphs 1979; J.K. Brown 1982; Simanton et al. 1990). Early spring or late summer burns can be used to promote native perennial grasses. There is little postfire recruitment for 3 to 5 years following a fire in perennial grasses, yet surviving grasses and accompanying forbs increase biomass production. Often, forbs will dominate an area for several years postburn. Harniss and Murray (1973) found increases in herbage production for 20 years after a burn.

Attempts at restoring sagebrush rangeland to achieve higher biomass yields are being investigated (Downs et al. 1995). In general, shrublands that have been converted to grasses by large wildfires are difficult to restore. Fire negatively impacts soil seedbeds important for sagebrush regeneration (Blank et al. 1995). Sagebrush seed can be viable for up to 4 years. Sagebrush can be restored through reseeding. Downy brome seed banks present on sagebrush sites may

negatively influence reestablishment of native bunchgrasses and shrubs (Hassan and West 1986). If sagebrush is in good condition, an initial postfire influx of downy brome will occur if some plants are present on these sites. Given adequate precipitation, however, perennial native grasses and shrubs can outcompete downy brome by the second year (West and Hassan 1985). Postfire rehabilitation efforts can be unsuccessful if other measures, such as grazing management, are not incorporated (Evans and Young 1978).

Fire was an important natural disturbance in the pinyon-juniper biome before the introduction of livestock in the 19th century (Gottfried et al. 1995). It is estimated that small surface fires historically occurred every 10 to 30 years (Leopold 1924), and large stand-replacing fires occurred every 100 to 300 years (Miller and Rose 1999). Fires apparently restricted the junipers to shallow, rocky soils and rough topography (Arend 1950, Burkhardt and Tisdale 1969, O'Rourke and Ogden 1969). Under natural fire cycles, the successional stages following fire are typically annuals; mixed annuals and perennials; perennial forb; grass and shrub; shrub and pinyon-juniper; and climax pinyon-juniper. Young pinyon and juniper trees are readily killed by fires, but older trees may be less susceptible due to thicker bark and more open crowns.

The major human influence on pinyon-juniper woodlands and fire's role in these ecosystems has been ranching. Most of the western rangelands were overgrazed, especially in the period following the 1880s. Overgrazing has had an important effect on the role of fire in the woodlands. The reduction of cover of herbaceous species resulted in insufficient fuels for fires to spread and to control tree establishment. In woodlands, tree density has increased. In many rangelands, juniper woodlands have established, replacing shrub communities. Fires ignited by lightning or humans tend to be restricted in space. Fire suppression activities by land management agencies also reduced the occurrence of fires. Woodland and savanna stand densities have increased throughout most of the West.

Climatic fluctuations, such as the drought in the Southwest in the early 1950s and global climate change, also have affected the distribution of woodlands in the West. In the Intermountain West, Miller and Rose (1999) quantitatively established that the co-occurrence of wet climatic conditions, introduction of livestock, and reduced role of fire contributed to the postsettlement expansion of western juniper. Prior to 1880, fire was probably the major limitation to juniper encroachment.

During the 1950s and 1960s, large operations were conducted to eliminate the pinyon-juniper cover in the hope of increasing forage production for livestock (Gottfried and Severson 1993; Gottfried et al. 1995). Other objectives were to improve watershed condition and wildlife habitat. Mechanical methods, such as chaining and cabling, were used, and the resulting slash was piled and burned. Burning these large fuel concentrations generated high heat levels that damaged soil and site productivity (Tiedemann 1987). Many of these piled areas were sterilized and remain free of vegetation after over 20 years. Individual tree burning was used on some woodland areas. Most of the control operations failed to meet their objectives. Many areas failed to develop sufficient herbaceous cover to support renewed periodic surface fires. Prescribed fire, sometimes in association with the felling of trees, is used to restore areas where pinyon-juniper has encroached into shrublands.

Subtropical Desert Ecoregion

The Subtropical Desert Ecoregion occupies southeast California, southern Nevada, Arizona, New Mexico, and western Texas, and includes the Chihuahuan, Sonoran, and Mojave deserts. Vegetation is adapted to dry conditions, and includes numerous xerophytic plants, such as small, hard-leaved or spiny shrubs, cacti, or hard grasses, which are widely spaced and provide little ground cover. Large portions of these hot deserts have no visible plants and are made of shifting sand dunes or nearly sterile salt flats. Approximately 29 million acres of public lands occur in this ecoregion.

Although major fires were not historically common in this region due to the wide spacing between plants and sparse fuels, the invasion of fire-prone species (e.g., red brome, downy brome, and buffelgrass) has shortened the fire interval in some areas, resulting in significant changes in plant communities.

Evergreen shrub communities are prevalent in desert habitats on over 23 million acres of public lands. On the plains of the Sonoran Desert, shrublands of creosote bush and saltbush species cover extensive areas in nearly pure stands. Individual shrubs are typically widely spaced, with large amounts of bare ground in between.

Large plants, such as the treelike saguaro cactus, prickly pear cactus, ocotillo, creosote bush, and smoke tree

often form communities with a near-woodland appearance. They are commonly associated with blue paloverde, bursage, mesquite, desert ironwood, crown of thorns, jojoba, acacia, and many species of cactus, yucca, and agave.

In the Mojave Desert, Joshua tree shrublands are widespread. Other common shrubs in this region include creosotebush, bursage, thornbush, shadscale, all scale, spiny hopsage, and greasewood. The Mojave Desert is especially rich in annual plants, which are abundant during the rainy season in winter and spring (Brown 1982).

Shrublands occurring adjacent to shallow playa lakes and desert washes, and in other moist habitats, have a unique species composition. Greasewood and catclaw acacia, which occur as scattered individuals in many plant communities throughout the ecoregion, often form pure stands in desert washes. Mesquite is another shrub species that may be found growing along washes and watercourses. Shrubs associated with alkaline soils near playas include mesquites, whitethorn acacia, blue paloverde, ironwood, desert willow, and canyon ragweed.

Evergreen shrublands in the Chihuahuan Desert include such species as mesquite, American tarwort, acacia, and creosotebush. Shrubs have recently increased in density in the Chihuahuan Desert, which is thought to have historically existed as open grassland or grassland scattered with shrubs (Buffington and Herbel 1965). Evergreen shrublands grade into grasslands, with the relative abundance of each plant community determined by such factors as fire, grazing, climate change, and seed dissemination (Holechek et al. 1995).

Perennial grasslands occur on nearly 4 million acres in the high plains of southeast Arizona (in the Chihuahuan Desert), where they are best developed on deep, well-drained soils on level sites (Brown 1982). Black grama and tobosagrass grasses are characteristic, along with sideoats grama and hairy grama, bush muhly, vine and curly mesquite, pappusgrass, tanglehead, and threeawn. Shrubs and succulents characteristic of this grassland include yucca, bear grass, agaves, sumac, ocotillo, acacias, mimosas, and cacti.

Deciduous and evergreen woodlands occur in select areas on over 1 million acres, predominantly on higher elevation slopes (pinyon-juniper woodlands) and in eastern New Mexico (oak and mesquite woodlands).

Fire Ecology

Prior to Euroamerican settlement, fires in desert habitats were set by lightning and Native Americans (Komarek 1969, Humphrey 1974). European settlers, however, suppressed fires and deliberately overgrazed rangelands to reduce fuels and use most of the grassland resources (Smith 2000). The reduction of major fires, together with the grazing of native grasses and the accompanying soil erosion, has caused shrubs to invade desert grasslands, thereby expanding in area and converting the structure of grasslands to shrublands (Bahre 1985). Wildfire risk varies from low in sparsely vegetated habitats (e.g., saltflats) to high in areas with heavy fuel loadings (e.g., mesquite shrublands). Introduced grasses such as red brome and lovegrasses provide herbaceous-level fuels that significantly increase the risk of a damaging wildfire in these habitats.

In many areas of the Mojave and Sonoran deserts, plant communities are too sparse during most years to adequately carry a prescribed burn. Therefore, this type of treatment would not be suitable for these areas. In areas that have increased fuel loading as a result of invasive annuals like red brome, prescribed fire would negatively affect plant communities by encouraging the further spread of these invasive species. In the denser desert shrublands, where there is an adequate amount of fuel to support a fire, many shrubs, trees, and cacti could be severely affected by burning, as these species are not adapted to fire. Paloverde, burroweed, bursage, broom snakeweed, ocotillo, and creosote bush are examples of desert species that can suffer high mortality rates from burning (Wright and Bailey 1980; Paysen et al. 2000).

Mesquite density and distribution increased prior to 1900 with fire suppression and seed dispersal by livestock. After 1900, mesquite continued to increase even though numerous eradication practices such as biological control, herbicides, mechanical removal, and prescribed burning were used to limit its density and spread (Glendening 1952, Wright and Bailey 1982, Wright 1990, Jacoby and Ansley 1991).

Fire as a management tool for controlling mesquite has its limitations. Mesquite may become more prevalent 5 years following a burn than it was before fire (Martin 1983). Mesquite can root sprout and top-killed individuals may resprout from dormant buds found in upper branches or from the base of the trunk below the ground surface. Mesquite seedlings can survive fire (Cable 1961), but on a burned site mesquite is

sometimes reduced (Wright 1980). Fire may kill a good proportion of mature mesquite, particularly the smaller trees (>2 inch diameter; Cable 1949, 1973). It is most susceptible to fire during the hottest and driest part of the year (Cable 1973). Drought years may increase mortality of mesquite if eradication is attempted. If managers wish to open dense mesquite stands, then roots as well as aboveground biomass must be killed. Fire can be used to reduce the density of young mesquite populations, particularly during dry seasons that follow 1 to 2 years of above normal summer precipitation (Wright 1980). Adequate precipitation, no grazing, and using fire about every 10 years allow grasses to successfully compete with mesquite. Rehabilitation of mesquite-invaded grasslands requires removal of livestock before burning, otherwise the shrubs outcompete the grasses (Cox et al. 1990). Shrub reinvasion depends on grazing management combined with continued use of fire at the desired frequency (Wright 1986).

In managing for mesquite savanna, shaded rangeland may be a preferred condition, rather than complete eradication of mesquite (Ansley et al. 1995, 1996). Low-intensity fire may allow mesquite to retain apical dominance on upper branches while reducing overall foliage. Season, air temperature, relative humidity, and duration and temperature of fire are factors that appear to affect the response of mesquite to fire (Paysen et al. 2000). Mesquite topkill is related to heat in the canopy, not at the stem bases. Single and repeated summer burns kill mesquite aboveground, but do not kill roots (Ansley et al. 1995). Prescribed burning may be used to kill mesquite seedlings, while leaving tree-sized individuals alive.

Prior to 1900, fires in paloverde-cactus shrub were not considered to be important and occurred mainly in the restricted desert grasslands (Humphrey 1963). Conversion of desert shrubland to grassland to enhance forage for livestock and wildlife was the primary land-use goal during the 1800s (Phillips 1962; Martin and Turner 1977).

Since 1900, increases in ignitions and fire size are evidence of changing land management practices in the paloverde-cactus shrub. Exotic grass invasion now supplies a contiguous fuel source in many areas so that the historical small and infrequent fires have been replaced by more frequent and larger fires (Narog et al. 1995). Rogers (1986) speculated that finer fuels and higher rates of spread may allow desert fires to become larger than nondesert fires before being controlled. Although many of the species in this vegetation type can resprout (Wilson et al. 1995b), postfire communities generally experience changes in species composition, particularly with an increase in the grass component, at the expense of cacti and succulents (Rogers and Steele 1980, McLaughlin and Bowers 1982, Cave and Patten 1984).

The increase in fire frequency and size may have serious consequences, particularly for plant and wildlife species of special interest, such as the giant saguaro (Thomas 1991) and the desert tortoise; both may be fire intolerant.

Temperate Steppe Ecoregion

The Temperate Steppe Ecoregion, which is typified by a semiarid continental climate, includes the Rocky Mountains and the Great Plains. Vegetation communities adapted to this climate include steppe, or shortgrass prairie, and semidesert, as well as the evergreen and deciduous forests and woodlands of the Rocky Mountains. Approximately 19 million acres of public lands occur in this ecoregion.

Perennial grassland communities are widespread in this ecoregion (over 4 million acres), which includes the prairie grasslands of the Great Plains, the Palouse grasslands of Oregon, Washington, and Idaho, and the mountain grasslands of the Rocky Mountains.

Prairie grasslands, which occur on the broad, flat belt of land that slopes eastward from the foothills of the Rocky Mountains, vary in height in response to precipitation. Dominant grasses in the shortgrass communities are buffalograss and blue grama, which occur with other herbs, as well as some woody species, including mesquite, sagebrush, and yucca.

Mixed grass communities include both warm-season (e.g., blue grama) and cool season species, such as needlegrasses, wheatgrasses, and fescues grass species. Shrubs, including juniper, sagebrush, rabbitbrush, and forbs are also important components of mixed grass communities (Brown 1982).

The Palouse grasslands, or northwest bunchgrass prairies, are dominated by bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and rough fescue. Many of the introduced species are Mediterranean annuals that are well adapted to grazing and the predominantly winter precipitation regime.

Perennial mountain grasslands are scattered throughout areas at elevations from 3,000 to over 9,000 feet in the

Rocky Mountains, particularly in western Montana. These grasslands are part of the vegetation mosaic created by the highly complex environment of the Rocky Mountains. Important grasses in these communities include bromes, bluegrasses, oatgrasses, sedges, wheatgrasses, fescues, needlegrasses, hairgrasses, reedgrasses, bentgrasses, and junegrass. Forb components vary with site, latitude, and management. Shrubs include several species of sagebrush, rabbitbrush, snakeweed, shrubby cinquefoil, rose, horsebrush, and prickly pear cactus (Mueggler and Stewart 1980).

Evergreen forests occur on over 2 million acres in the mountain regions, with species composition that varies by altitude. Subalpine forests are composed of Engelmann spruce, subalpine fir, and mountain hemlock. Below this zone, Douglas-fir, western white pine, grand fir, western larch, lodgepole pine, and ponderosa pine are common. Lodgepole pine or ponderosa pine forests may occur at the lowest elevations, and often grade into grasslands or evergreen shrubland. Fire is an important component of all of these forests, with the highest natural frequency on the lowest elevation sites. Lodgepole pine is specifically adapted to regenerate after fire.

Deciduous forests may occur along streams and rivers in the eastern portion of this ecoregion. Eastern species such as ash, hackberry, elm, birch, and bur oak may be found. Deciduous forests composed of quaking aspen are prevalent throughout the Rocky Mountains up into Alaska (DeByle and Winokur 1985). Aspen may form extensive pure stands or exist as a minor component of other forest types.

The most common type of shrubland in this ecoregion is sagebrush steppe. Sagebrush-dominated communities occur on the plains and lower mountain slopes on nearly 8 million acres. Chaparral shrublands and pinyon-juniper woodlands (2 million acres) are also found in some of the lower elevation areas on warm, dry sites.

Fire Ecology

Perennial Graminoid – Grasslands. Fire was not a predominant force in delimiting the extent of the Plains grasslands. However, given their existence and their flammability characteristics, the presence of fire must have had an impact on the character of the grasslands and their species composition and distribution. Modifications of climate and soil development led to invasion of some grassland areas by woody species. Under these circumstances, fire probably played a distinct role in the maintenance, or loss, of these grassland areas. Working in concert with grazing animals, fire could check the advance of more fire-sensitive, woody species, provided enough grass fuel was available. It could also encourage the advance of woody species that were adapted to disturbance and harsh climate conditions. Where invasion by woody species was not an issue, fires could maintain highly productive grasslands, and cause shifts in grassland species composition in others. Under conditions of drought, fire could result in severe site damage (Paysen et al. 2000).

Clearly, fire was a common element in presettlement times, and frequency might have increased with the arrival of Euroamerican settlers (Jackson 1965). For years, attempts to suppress fires in the Plains were either nonexistent or ineffective. As late as the 1890s, from the Dakotas to the Texas Panhandle, fires would run unchecked for days. During this period, fire, drought, and grazing played a role in maintaining, and at times debilitating, the grassland character. When fire or any other phenomenon that reduced the vegetative cover occurred during periods of serious drought, wind erosion often retarded the processes of succession (Paysen et al. 2000).

Perennial Graminoid – Mountain/Palouse Grasslands. Although bunchgrass species vary in their individual susceptibility to fire damage, repeated fires at intervals of about 5 to 40 years historically maintained the bunchgrass community (Gruell et al. 1986). The abundance of individual species varied by site conditions and the actual frequency and seasonal timing of fire. A successional process of major importance was the continual checking and reduction of woody plant encroachment.

Grazing by livestock, elimination of Native American ignitions, and fire control efforts greatly reduced the amount of fire in these grasslands. As a result, species such as ponderosa pine, Douglas-fir, lodgepole pine, and sagebrush have increased substantially along ecotonal boundaries. In some areas, dense Douglas-fir forests now dominate sites to such an extent that evidence of former grasslands is lost except by soil analysis (Bakeman and Nimlos 1985). Elimination of periodic burning has apparently reduced diversity of herbaceous species in some areas (Wright and Bailey 1982).

A study of fire regimes in the Interior Columbia River Basin involving grasslands and other vegetation types suggests that human influences have had a variable

effect on the nature of fire regimes (Morgan et al. 1994). Fires tend to be less frequent, but not always more severe than they were in historic fire regimes. For example, where exotic annuals have invaded sagebrush steppe vegetation, fires have become so frequent that sagebrush does not have time to reestablish, and the annuals return quickly.

Evergreen Forests. Evergreen forests of the Rocky Mountains have historically had variable fire regimes, ranging from frequent, low severity understory burns in ponderosa pine forests to infrequent, stand replacing fires in lodgepole pine forests (Arno 2000).

A broad range of mid-elevation mountain forests dominated by interior Douglas-fir, western larch, or Rocky Mountain lodgepole pine were characterized by mixed fire regimes. They were abundant and diverse in western and central Montana (Arno 1980; Arno and Gruell 1983; Barrett et al. 1991). Mixed fire regimes allowed an open overstory of mature Douglas-fir and larch to survive many fires. Small trees and associated less fire-resistant species were heavily thinned by moderate-intensity burning. Additionally, some nonlethal underburns occurred in lodgepole pine stands having light fuels.

Effects of these variable fires often included maintaining a mosaic of small stands dominated by various age structures of seral coniferous species and seral hardwoods such as Scouler's willow and aspen. Some stands experienced nonlethal underburns that maintained open understories by killing saplings and fire sensitive species. Others experienced patchy fire mortality that gave rise to patchy tree regeneration, including that of seral species. Occasional large stand-replacement fires may have reduced spatial diversity, but the varying distribution of seed sources and sprouting shrubs in the preburn mosaic probably enhanced variability in postburn vegetation.

With a reduction in fire activity due to livestock grazing (removing fine fuels) and fire exclusion policies, young conifer stands have invaded former grasslands within or below the forest zone. The trees are densely stocked and subject to extreme drought stress. They often have poor vigor and are susceptible to western spruce budworm or other insect or disease attacks and to stand replacing fires. Productivity of seral herbs, shrubs, and aspen also declines dramatically in the continuing absence of fire. Stands within the forest zone may have undergone significant changes in recent decades. As a result of fire exclusion, the trees in most stands within the landscape mosaic have become older, and often have a buildup of down woody or ladder fuels. Recent wildfires have burned as larger stand-replacement fires than those detected in fire history studies (Barrett et al. 1991; Arno et al. 1993).

Deciduous Forests. Before settlement by Euroamericans, large expanses of aspen parkland existed in the western U.S. Aspen regenerates well after fire, suckering prolifically from roots. In the aspen parkland, these stands were often perpetuated as a shrublike cover by light- to moderate-intensity fires that swept across the prairie grasslands and ignited the aspen stands on a regular 3- to 15-year basis. In the Rocky Mountains, low-intensity fires caused thinning and encouraged all-aged stands, whereas high-intensity fires resulted in new even-aged stands.

Settlement of the West in the late 1800s and early 1900s increased fire frequency because of land-clearing fires, slash burning, and railway traffic (Murphy 1985). In more recent times, following the implementation of rigorous fire protection programs, lack of fire has threatened the continued existence of aspen in the West (Brown and DeByle 1987, 1989; Peterson and Peterson 1992). Fire suppression since the 19th century has altered dynamics in aspen stands in the mountainous western United States, changing fire frequencies from as little as 10 years (Meinecke 1929 *in* DeByle et al. 1987) to approximately 12,000 years (DeByle et al. 1987). Without the occurrence of disturbance, aspen clones mature in about 80 to 100 years (Schier 1975) and regeneration of this species is threatened. The dying back of those stands is now favoring shade-tolerant conifers or in some case grasses, forbs, or shrubs, depending on the availability of seed sources (Krebill 1972; Beetle 1974; Schier 1975; DeByle 1976; DeByle et al. 1987; Bergeron and Danserau 1993). Aspen stands are being replaced by conifers. Conversion to conifer stands may require the absence of moderate to high intensity fire for as little as one aspen generation to as long as 200 or more years in the southern boreal forest or in the Rocky Mountains (J. K. Brown 1985; Brown and Simmerman 1986; Bergeron and Dubuc 1989; Perala 1990).

Subtropical Steppe Ecoregion

The Subtropical Steppe Ecoregion, located in northern Arizona, New Mexico, and Texas, is composed of plateaus and high plains. Because of its altitude, the climate is semiarid, rather than arid. This region is composed primarily of grassland vegetation, with locally found shrubs and woodlands. Pinyon-juniper woodlands are common on the Colorado Plateau. To the

east, in New Mexico and Texas, grasslands grade into savanna woodlands or semideserts composed of xerophytic shrubs and trees. Approximately 13 million acres of public lands occur in this ecoregion.

The perennial graminoid communities in this region are composed of xerophytic grasses, with shrubs and low trees growing singly or in clumps, and occupy over 4 million acres. Common grass species include blue and hairy grama, buffalograss, threeawn species, sideoats grama, bluestem, and bristly wolfstail. Shrubs and trees, such as mesquite, oaks, and junipers, often grow in open stands among the grasses. The perennial grasslands grade into evergreen woodlands, with the respective coverage of each vegetation class dependent on the amount and type of disturbance to which a particular area is subjected.

Evergreen woodlands of drought-tolerant juniper and pinyon pines consist of a relatively open canopy on dry sites at mid-elevations on nearly 4 million acres. Plant composition in pinyon-juniper woodlands exhibits wide geographic variation. In the Colorado Plateau and the central and southern Rockies, doubleleaf pinyon replaces singleleaf pinyon and is associated with Rocky Mountain juniper, Utah juniper, and oneseed juniper (Cronquist et al. 1972). In the dry mountains of southern New Mexico and Arizona, alligator juniper, Emory oak, gray oak, and Mexican pinyon dominate (Brown 1982). The understory layer of shrubs, grasses, and forbs in these communities is composed of representatives from adjacent sites above and below the woodland zone. Important understory species include big sagebrush, western and bluebunch wheatgrass, blue grama, cliffrose, bitterbrush, Indian ricegrass, mountain mahogany, rubber rabbitbrush, and Mormon tea (Garrison et al. 1977).

It is estimated that small surface fires historically occurred every 10 to 30 years (Leopold 1924), and large stand-replacing fires occurred every 100 to 300 years (Miller and Rose 1999). Fires easily kill young trees and frequent fires maintain the sagebrush-grassland communities (West and Van Pelt 1987). Drought and competition from grasses probably helped slow the invasion of juniper into adjacent shrublands, particularly at lower elevations. Many pinyon-juniper sites may have historically cycled between grass-shrub and pinyon-juniper communities, with fire as the chief driving force (West and Van Pelt 1987).

At higher elevations (up to 7,000 feet), chaparral is a common type of evergreen shrubland on over 4 million acres, with pinyon-juniper and oak-juniper woodlands also occurring. Plant communities consist of dense to moderately open stands of evergreen and sclerophyllous shrubs of relatively uniform height. Most chaparral shrubs are deep-rooted, sprout readily from the root crown, and regenerate quickly after burning (Brown 1982). Shrub live oak is common, and associated with mountain mahogany, yellowleaf silktassel, sumac, hollyleaf buckthorn, pointleaf and Pringle manzanita, desert ceonothus, and other oak species. Grass species may include sideoats grama and hairy grama, cane bluestem, plains lovegrass, threeawn, and bristly wolfstail. Forbs are not particularly abundant, except during a brief period after burns (Brown 1982).

Evergreen forests occur at the highest elevations in this region. Over 7,000 feet, forests of ponderosa pine, Douglas-fir, lodgepole pine, limber pine, and aspen may be found. Engelmann spruce, corkbark fir, limber pine, and bristlecone pine occur in subalpine forests.

Fire Ecology

Perennial Graminoid. Grazing by livestock, elimination of Native American ignitions, and fire control efforts have greatly reduced the amount of fire in these grasslands. These and other human influences are similar to those described earlier for Perennial Graminoid – Mountain/Palouse Grasslands. Changes in fire regimes differ depending on whether active fire suppression results in the buildup of fuel, or if livestock grazing and other activities break up fuel continuity (Paysen et al. 2000).

Although bunchgrass species vary in their individual susceptibility to fire damage, repeated fires at intervals of 5 to 40 years historically maintained the bunchgrass community (Gruell et al. 1986). Encroachment into grasslands by woody species was an ongoing process kept in check by repeated fires.

Evergreen Shrubland (Chaparral). Chaparral shrub species in the Subtropical Steppe Ecoregion are fire-dependent, comprised of highly flammable species, and grow rapidly after fire, taking about 25 years to mature (Smith 2000). The production of dead fuels in chaparral stands is not well understood, but probably increases with age and after a drought. Fuels in chaparral communities are not as easily ignited as grass fuels, but will burn readily under hot, dry conditions.

Prescribed burns in chaparral communities would be expected to benefit these communities, provided fires were not too frequent or too hot, by reducing fuel accumulations and increasing structural diversity

(Paysen et al. 2000). Prescribed fire can be used to remove dead fuel for hazard reduction, increase structural diversity for wildlife habitat purposes, and increase the proportion of young biomass in a stand—for both fire hazard reduction and wildlife habitat improvement. In some areas, but not all, prescribed fire can be used to maintain stands of chaparral in their current state (that is, to maintain a fire climax).

Evergreen Woodland (Pinyon-juniper). The general effects of fire on pinyon-juniper woodlands in this ecoregion are largely the same as those on pinyon-juniper woodlands in the Temperate Desert Ecoregion. Surrounding communities that have been invaded by pinyon and juniper trees tend to benefit from fire, while communities with a large component of non-native species, or dense pinyon-juniper stands that have little understory vegetation, tend to be adversely affected.

Mediterranean Ecoregion

The Mediterranean Ecoregion occupies most of California (excluding deserts in the southeastern portion of the state) and a portion of southern Oregon. This region supports a distinctive assemblage of hard-leaved evergreen trees and shrubs, commonly known as chaparral, which are adapted to withstand severe summer droughts and frequent fires. Coniferous forests and oak woodlands are also characteristic of the region. Approximately 6 million acres of public lands occur in this ecoregion.

Evergreen shrubland occurs on over 2 million acres. Along coastal areas a type of chaparral known as maritime chaparral is common. Inland evergreen shrublands are found in the low hills of mountainous regions, often forming a mosaic pattern with deciduous (oak) woodlands, grasslands, or evergreen forests. Important chaparral species include manzanita, wedgeleaf ceanothus, hollyleaf buckthorn, poison oak, chamise, Christmasberry, mountain mahogany, California scrub oak, blue oak, and interior live oak (Holechek et al. 1995). Chaparral shrubs are adapted to recurrent fire, and the ecosystem depends on periodic fires for its persistence. Herbaceous vegetation is generally lacking in chaparral communities, except after fire.

Nearly 1 million acres of deciduous woodlands and evergreen woodlands also occur in foothills throughout California, typically on sites that are more mesic than those occupied by chaparral. Deciduous oak woodlands include stands of Oregon white oak, California black oak, blue oak, valley oak, and various other oaks. On cooler, moister sites in the Coast Ranges, oak woodlands merge with mixed hardwood forests in which tanoak, California laurel, and Pacific madrone are common. Evergreen live oaks are common associates, and conifer species such as Coulter pine, digger pine, Douglas-fir, and grand fir may also be present. Understory vegetation varies by location and may include poison oak, snowberry, serviceberry, blackberry, wild oats, bromes, bluegrass, ryegrass, and needlegrass.

Evergreen woodland communities composed of live oaks occur in moist, frost-free areas such as the coastal hills from San Francisco into southern California, where adequate moisture and mild temperatures allow them to carry out photosynthesis through the winter. Evergreen oak woodlands are composed of species such as canyon live oak, interior live oak, coast live oak, and Engelmann oak. Oak woodlands may exist as open, park-like savannas, occupying a transition zone between grasslands and denser woodlands. Shrubs are generally absent because they cannot compete with trees for moisture on drier sites. Evergreen woodlands also include some endemic tree species such as Monterey cypress, Torrey pine, Monterey pine, and Bishop pine.

In the mountains of California and southern Oregon, evergreen forests are the dominant vegetation type, occupying nearly 2 million acres of public lands. These forests are a diverse assemblage of many conifer species, and are adapted to a long, warm growing season, relatively mild winters, and periods of summer drought. Tree species include ponderosa pine, Douglas-fir, white fir, sugar pine, incense cedar, Jeffrey pine, California red fir, and giant sequoia (Szaro 1995). At elevations between 6,500 and 9,500 feet, subalpine forests composed of mountain hemlock, California red fir, lodgepole pine, western white pine, and whitebark pine occur.

Evergreen forests also occur along coastal northwestern California as redwood-dominated communities. Other common tree species forests include Douglas-fir, western hemlock, and western red cedar. The understories are dominated by Pacific rhododendron, western azalea, salal, California huckleberry, western swordfern, and redwood sorrel. Pine-cypress forests also occur along the coast, while mixed forests of tanoak, coast live oak, madrone, and Douglas-fir occur further inland.

For the most part, annual and perennial graminoid communities are located in the valleys and plains of the Mediterranean Ecoregion. While it is generally believed

that the Central Valley, the largest grassland expanse in California, was historically dominated by perennial grassland communities, other plant communities (e.g., oak woodlands, chaparral, annual grasslands, and desert scrub) may have also been present (Blumler 1992, Hamilton 1997). Large portions of the native vegetation have been replaced by annual grasses, however, as a result of introduced species, fires, and overgrazing by livestock of early Spanish settlers (Sims 1988). Annual grasses include introduced species such as wild oat, slender oat, soft chess, ripgut brome, red brome, and wild barley. Common forbs include redstem filaree, broadstem filaree, turkey mullein, true clovers, and burclover. Perennial grasses, which are found in moist, lightly grazed or relict areas, include Idaho fescue and purple needlegrass (Garrison et al. 1977). With the development of irrigation, the California grassland ecosystem has become intensively utilized for agriculture.

Fire Ecology

Evergreen Forest. Evergreen forests in this region historically had an understory fire regime or a mixed severity fire regime, and are presently at risk for high-intensity, stand-replacing crown fires due to large fuel accumulations. Suppression of the mixed patchy fires in high elevation forests may eventually result in a landscape mosaic consisting largely of contiguous stands with comparatively heavy loadings of dead trees (standing and fallen) and canopy fuels.

Evergreen Woodland (Oak Woodlands). In recent centuries, fire regimes in western oak forests were characterized by frequent, low intensity fires. This was probably due to use of these types by Native Americans, who likely carried out programs of frequent underburning. Frequent, low intensity fires, helped to maintain open stands with a grassy understory. In the last half of the 20th century, higher intensity fires at longer intervals were more common. Such fires can kill a stand of oaks outright (Smith 2000), although most oaks will resprout after fire if the underground portions of the plant are still alive (Plumb 1980). The introduction of annual grasses into oak woodlands has increased the seasonal period during which fires can occur, enabling them to burn and spread earlier in the season (USDA Forest Service 2002b). Because conditions in oak woodlands have changed significantly since historic fire regimes, there are many concerns surrounding the use of prescribed fire in these systems.

Evergreen Shrubland (Chaparral). Chaparral succeeds many forest types after a major disturbance, whether from fire or logging. It is often seral, especially at elevations where we currently consider chaparral as a montane understory type. Given a reasonable number of disturbance free years, the forest type will regain dominance. Chaparral often succeeds chaparral after fire, especially at elevations where chaparral is the dominant vegetation type. Species composition can shift drastically, probably depending on whether the fire occurred before or after seed set for a given species. Fire frequency and timing can cause chaparral to be overtaken by herbaceous vegetation types, such as annual grasses.

Marine Ecoregion

The Marine Ecoregion Division occupies the Cascade and Coast Ranges of western Washington and Oregon, and the Coast Mountains of southeastern Alaska, along the Pacific Coast. The mild, rainy climate produces conditions that are hospitable for dense forest communities, which are characteristic of this region. Approximately 4 million acres of public lands occur in this ecoregion.

In the Cascade and Coast Ranges, complex, multi-storied evergreen forests occupy over 1 million acres, with species composition varying by altitude and climate. At lower elevations, Douglas-fir, western red cedar, western hemlock, grand fir, silver fir, Sitka spruce, and Alaska cedar are the dominant tree species. Subalpine forests composed of mountain hemlock, subalpine fir, whitebark pine, and Alaska cedar extend to timberline, which varies from 7,700 to 10,000 feet. In the drier climates of the eastern Cascade Range, forests dominated by ponderosa pine are common. Evergreen forests are often associated with understory plants such as vine maple, huckleberry, elderberry, salal, Oregon grape, twinflower, and western swordfern (Franklin 1988).

The area between the Cascade and Coast ranges is also characterized by dense evergreen forests. Much of the land in this intermountain region once existed as Douglas-fir, western redcedar, and western hemlock forests, but has since been developed for agricultural and urban uses.

Evergreen forests are also the predominant vegetation type found in the Coast Mountains of southeastern Alaska. Forests in this region are restricted to low elevation, coastal rainforests dominated by Sitka spruce and western hemlock. Associated species include Alaska cedar and mountain hemlock.

Along the major river channels, deciduous riparian forests composed of broadleaf trees such as black cottonwood, red alder, willow, and birch are common. In poorly drained areas, wetlands characterized by sphagnum moss, sedges, and willows occur.

Vegetation types with minor coverage in the Marine Ecoregion include Oregon white oak woodlands, which occur as scattered stands at low elevations, and prairies (perennial graminoid communities), which now occur only as remnant patches in the Willamette Valley and Puget Sound lowlands. Both of these community types are being lost as a result of succession by evergreen forests and development.

Fire Ecology

Evergreen Woodland (Oak Woodlands). Open woodlands dominated by Oregon white oak once occupied the driest climatic areas throughout the Puget Sound-Willamette Valley lowlands and southward in dry valleys behind the coastal mountains to the California border. Oregon white oak dominated in open woodlands and savannas associated with valley grasslands, and isolated small prairies that were surrounded by the extensive coast Douglas-fir forest. Oak woodlands also were associated with droughty sites such as bedrock with shallow soils on the southeast coast of Vancouver Island and in the San Juan archipelago, in the rain shadow of the Olympic Mountains.

Journal accounts and archeological sources show that extensive oak woodlands of the Willamette and other major valleys persisted as a "fire climax" maintained by frequent aboriginal burning (Habeck 1961; Boyd 1986, 1999; Agee 1993). Prior to the influx of Euroamerican settlers in the mid-1840s, the Kalapuyan Indians and other tribes typically set fire to large areas of Oregon oak woodlands to aid hunting and food plant harvest, and for other purposes (Boyd 1986). Burning was commonly done in September, and many areas were burned at short intervals, perhaps annually in some areas. Similar patterns of frequent burning to maintain valley grasslands, isolated prairies, and open oak woodlands are described from northwestern Washington southward to central California (Lewis 1973; Boyd 1986, 1999), but these practices are well documented only in the Willamette Valley of northwestern Oregon. Most of these fires must have been characterized by short duration flaming as they quickly consumed grass and litter that had accumulated since the previous burn. The thick-barked oaks survived, but regeneration of all shrubs and trees would have been heavily thinned by frequent burning.

In former oak savannas, fire exclusion has led to an increased density of shrubs and oaks, transforming them into woodlands (Agee 1993). In former oak woodlands, shrubs, Douglas-fir, and other tree species are replacing oaks. Livestock grazing and fire exclusion have been major factors in the successional change that has occurred in Oregon oak woodlands since Euroamerican settlement. Logging, clearing, and firewood harvest also have changed many woodlands. Additionally, large areas of oak woodlands have been displaced by agriculture and urbanization.

Evergreen Forest. These humid maritime forests are extensive at lower and middle elevations west of the Cascades and British Columbia Coast Range. The cooler, wetter, and more northerly portions of the coastal Douglas-fir type (generally associated with the mountains of western Washington and southwestern British Columbia) burned in stand-replacement fires at long intervals, averaging 200 to several hundred years (Agee 1993). The range of pre-1900 fire intervals on a given site is unknown because in most cases only the most recent interval can be calculated due to decay of the previous stand. Long et al. (1998) described fire intervals over the last 9,000 years, and Impara (1997) reports on the spatial patterns of historical fires in the Oregon Coast Range.

Western hemlock is the potential climax dominant tree in most of this type, but seral Douglas-fir, which arose after replacement fires during the last several hundred years, is the actual dominant. The greater size and longevity of Douglas-fir allows it to persist in considerable quantities for 700 to 1,000 years between major stand-opening disturbances such as fire or severe blowdowns (Agee 1993). Scattered individual Douglas-fir survived fires and served as seed sources in the burn. Seeds of this species may also survive and mature in the crowns of some trees whose foliage was killed (but not consumed) by a late-summer fire. The seeds are also wind-dispersed from unburned stands. Douglas-fir seedlings grow readily on burned seedbeds and outcompete other conifers in the postburn environment.

Often red alder becomes abundant and temporarily outgrows Douglas-fir in a recent burn. However, the fir grows up beneath and displaces alder within a few decades, benefiting from soil nitrogen fixed by symbiotic organisms associated with alder roots. Numerous other seral conifers (e.g., western white pine, shore pine, grand fir, Sitka spruce) and hardwood

species (e.g., bigleaf maple, American mountain ash, cascara buckthorn), as well as seral shrubs (salmonberry, huckleberries) and herbaceous plants, appear in the postburn environment (Fonda and Bliss 1969, Franklin and Dyrness 1973, Hemstrom and Franklin 1982, Huff 1984, Yamaguchi 1986).

Large areas of these forests have been clearcut in recent decades, sometimes followed by broadcast burning. This has given rise to large areas of early seral communities dominated by native flora, often with planted Douglas-fir, which might offset a shortage of early seral communities resulting from natural fires. However, natural burns and clearcuts differ ecologically, for example in seedbed preparation, in providing residual large woody debris, and in having an overstory of dead trees (Kauffman 1990).

Vegetation Condition and Fire Regimes

In support of national-level fire planning and ecological assessment, the Fire Regime Condition Class (FRCC) concept was devised. The BLM uses the FRCC concept to describe ecological departure. It is a measure that helps to describe common issues on public lands, such as altered disturbance regimes, invasive species, or highly altered plant communities. Generally, FRCC is one piece of information used to describe the health of public lands.

The first national FRCC assessment was completed in the late 1990s and published in *Development of Coarse-scale Spatial Data for Wildland Fire and Fuel Management* (Coarse Scale; Schmidt et al. 2002). This analysis was used in the Draft PER. This assessment excluded public lands in Alaska (86 million acres), as well as 25.5 million acres of agricultural, barren, and urban/developed lands in the lower 48 states. Three condition classes were established to represent qualitative measures describing the degree of departure from historical fire regimes. Departure from historical fire regimes may result from activities, such as fire exclusion, timber harvesting, livestock grazing, introduction and establishment of exotic plant species, introduced insects or disease, and/or other management activities, that alter key ecosystem components such as species composition, structural stage, stand age, canopy closure, and fuel loadings.

While the intent of the Coarse Scale analysis was regional and national characterization, USDI agencies found the analysis to be of limited utility, especially for public lands in the western U.S. The condition classes in the Coarse Scale analysis were assigned based on successional stages for potential natural vegetation groups. Public lands were poorly represented in this effort for two reasons. First, some vegetation types, such as annual grasses or woodlands, could not be discerned in the vegetation classification used (Kuchler's Potential Natural Vegetation Groups; Kuchler 1964). Second, condition class assignments relied heavily on forest canopy cover thresholds, which have limited applicability to the majority of public lands.

Because of these shortfalls, a second national FRCC analysis was conducted as part of the Rapid Assessment Phase of the Landscape Fire and Resource Management Planning Tools Project (LANDFIRE). The Rapid Assessment Phase is intended as an interim product while further refinement of LANDFIRE continues. LANDFIRE is a 5-year, multi-partner project producing consistent and comprehensive maps and data describing vegetation, wildland fuel, and fire regimes across the United States. It is a shared project between the wildland fire management programs of the USDA and USDI.

Intended to better represent USDI-administered lands, the Rapid Assessment Phase mapped FRCC based on potential natural vegetation groups (historic vegetation), S-class (current seral stages), and historic fire regimes of the coterminous United States. Despite some localized inaccuracies, the Rapid Assessment Phase layer is the most accurate FRCC summary map for lands managed by the BLM, to date. Like the first national FRCC assessment, the second national FRCC assessment also excluded lands in Alaska as well as agricultural, barren, and urban/undeveloped lands in the lower 48 states.

The Rapid Assessment Phase is primarily intended for use at the national, regional, or state level, but not the local level. As a result, the Rapid Assessment Phase, like the Coarse Scale Analysis, is not intended to portray district or field office site conditions. FRCC can be assessed at the local level using a variety of tools (besides the national map), such as the FRCC software or GIS mapping tools. For this Final PER, departures from historical fire regimes are based on the Rapid Assessment Phase analysis, and have been grouped into three classes, as shown on Map 3-10. **Condition Class 1** lands (27.2 million acres of public lands; acres are approximate as federal agencies are updating and refining acreage estimates) are characterized by fire regimes that are within their historical range of

vegetation variability characteristics, fuel composition, and fire frequency, severity, and pattern. Fire behavior, effects, and other associated disturbances are comparable to those that took place prior to management practices that do not mimic the normal fire regime. The structure and composition of vegetation and fuels are similar to the historical regime, and the risk of losing key ecosystem components to fire is low. These areas can generally be maintained within the historical fire regime with treatments such as prescribed fire. Wildland fire use for resource benefit may also be used to maintain these areas.

Condition Class 2 lands (79.5 million acres) have fire regimes that have been moderately altered from their historical conditions. They experience either an increased or decreased fire frequency of one or more return intervals, resulting in changes to fire size, intensity, and severity, and/or landscape patterns. Vegetation composition and structure and fuels have been moderately altered from their historical range, and have a moderate risk of losing key ecosystem components due to fire or other causes. These lands may need moderate levels of restoration treatments, such as prescribed fire and hand or mechanical treatments, to be restored to the historical fire regime.

Condition Class 3 lands (54.7 million acres) have fire regimes that have a high departure from the historical condition, and the associated risk of losing key ecosystem components to fire or other causes is high. Vegetation composition, structure, and diversity, as well as fuels, have been significantly altered from their historical range. Due to these alterations, Condition Class 3 areas are especially susceptible to severe and intense wildland fires. These areas often require high levels of restoration treatments, such as hand or mechanical treatments, before prescribed fire can be used to restore the historical fire regime (Schmidt et al. 2002). Almost 41% (21.2 million acres) of the Class 3 lands occur in the Temperate Desert Ecoregion. 15.5 million acres occur in the Subtropical Desert Ecoregion, 8.2 million acres occur in the Temperate Steppe Ecoregion, and 5.4 million acres occur in the Subtropical Steppe Ecoregion. An additional 1.5 million acres of Class 3 lands occur in evergreen forests of the Mediterranean Ecoregion.

A comparison by acreage shows that the acreage of FRCC Condition Class 3 lands increased substantially between the Coarse Scale and Rapid Assessment Phase analysis. The Rapid Assessment Phase analysis further supports the need for treatment of large numbers of acres in the West to improve condition class.

Further information and methods can be found at the FRCC website and in the Interagency FRCC Guidebook (www.frcc.gov).

Noxious Weeds and other Invasive Vegetation

Invasive plants are undesirable plants that infest land or deplete water resources, and may cause physical and economic damage or have other adverse effects on humans. Invasive plants are increasingly recognized as a major threat to ecosystems. Many invasive taxa have transformed both the structure and function of ecosystems by changing nutrient cycling or disturbance regimes (D'Antonio et al. 1999; Rejmanek et al. 2005). The spread of invasive plants threatens the structure and function of many ecosystems worldwide (Higgens et al. 1996; Drake et al. 1989). Certain invasive plant species have the ability to spread over large areas or acutely threaten an ecosystem over its continental range (Hobbs and Humphries 1995). There are estimated to be over 2,000 species of non-native plants in the U.S. (U.S. Congress Office of Technology and Assessment 1993), over 1,000 of which are invasive (Rejmanek et al. 2005). Approximately 10% of invasive species have profound effects on biodiversity, and clearly demand a major allocation of resources for containment, control, and/or eradication.

Noxious weeds are invasive plants that are designated and regulated by state and federal laws, such as the Federal Noxious Weed Act, because they are detrimental to agriculture, commerce, and/or public health. Noxious weeds are generally non-native invasive plants that have been either accidentally or intentionally introduced.

The Extent of the Problem

It is estimated that invasive plants already infest well over 100 million acres in the U.S., and they continue to spread at an estimated rate of 3 million acres annually (USDI BLM 1998a). Weed infestations are capable of destroying wildlife habitat; reducing opportunities for hunting, fishing, camping and other recreational activities; displacing many threatened and endangered species; reducing plant and animal diversity because of weed monocultures; and costing millions of dollars in treatments and loss of productivity to land owners.

Besides ecological changes, invasive plants can cause impacts to public safety. While the spread of downy brome has increased the frequency and severity of fires,

to the detriment of native plants and animals, as well as property and human safety, other species have caused unforeseen disasters as well. In 1936, for example, the town of Bandon, Oregon, was destroyed and 11 citizens killed by a fire propagated by gorse, a highly flammable plant introduced 70 years earlier (Simberloff 1996). This species is still being battled along the Oregon and California coasts.

Traits of Invasive Plants

Invasive plants and noxious weeds have biological traits that enable them to colonize new areas and successfully compete with native species. While not all invasive species share many of these traits, most species have one or more that allow them to compete successfully. These traits may include deep tap root systems and very little surface foliage (allowing the plants to grow later in the summer than most native rangeland plants); earlier growth and reproduction than most natives; long-lived seeds in a viable seedbank; adaptations for spreading long and short distances; production of many seeds from one plant; long lifespan; ability to delay flowering; ability to reproduce vegetatively; tolerance for a wide range of physical conditions; rapid growth; self pollination; ability to compete intensively for nutrients; and production of toxic compounds that negatively affect neighboring plants (adapted from USDA Forest Service 2005).

Some plant communities and ecosystems are more susceptible to plant invasion than others. Very few invaders are successful in successionally advanced plant communities. Open and disturbed communities are more invaded, while undisturbed forests are less invaded (Rejmanek et al. 2005).

Mechanisms of Invasion

Invasive plants have been introduced into the U.S. through a variety of pathways. Some non-native species were intentionally introduced for beneficial reasons and later became invasive. Purple loosestrife, which was originally introduced in ballast water dumped from ships coming from Europe, is still sold as an ornamental plant in garden centers in many states. Dalmatian toadflax is another introduced ornamental that can still be found in garden seed mixes. Saltcedar was introduced for erosion control, as was European beachgrass along the West Coast. Many other invasive plants have been introduced unintentionally via air, water, rail, or road transportation pathways. Common methods of introduction include contaminated seed, feed grain, hay, straw, and mulch; movement of contaminated equipment across uncontaminated lands; animal fur and fleece; spreading of gravel, roadfill, and topsoil contaminated with noxious weed seed; and plants and seeds sold through nurseries as ornamentals (USDI BLM 1996).

Once introduced, invasive plants are spread primarily by vehicles, humans, wild horses, livestock, wind, water, and wildlife. Initially, invasive weeds may become established in disturbed sites such as trailheads, along roads and trails, firebreaks, landing pads, oil and gas development sites, wildlife and/or livestock concentration areas, and campgrounds, but may also invade relatively undisturbed sites.

The plant invasion process occurs in three phases: introduction, establishment, and spread. Once an introduction occurs, a delay or lag phase often takes place while an invasive plant becomes established. The length of this initial phase varies, but it can last for up to 100 years (Hobbs and Humphries 1995). This phase is followed by a period of rapid growth that continues until the invasive species reaches the bounds of its new range (Figure 3-1; Mack et al. 2000).

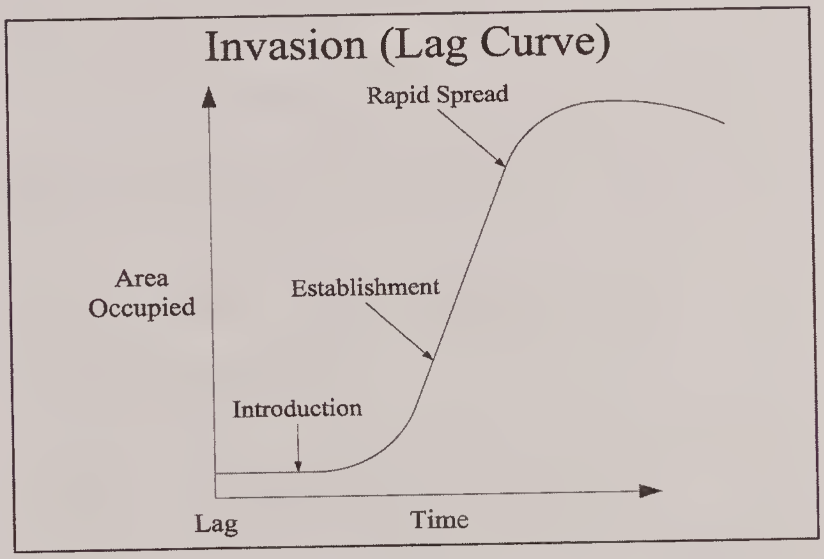

Figure 3-1. Relationship between Area Occupied by Invasive Species and Time.

Understanding this process is critical for making timely and appropriate decisions for managing invasive plants. Preventing the spread of species during the lag phase should be a priority for managers. The establishment phase, while enough residual desired vegetation remains, should be another crucial time for controlling infestations (USDA Forest Service 2005).

Sleeper weeds, a relatively new concept, are invasive plant species with populations that are known to have increased significantly more than 50 years after

becoming naturalized (Groves 2006). Common reed, for example, has been identified as a sleeper weed in Quebec, Canada. While the species has been present in Quebec since 1916, it did not spread on a large scale until the 1960's, most likely after the development of the highway network (Lelong et al 2007). Controlling newly introduced populations of non-native species should help to alleviate the development of sleeper weeds.

Maintaining cover of native plant species on public lands may be critical to halting the spread of noxious weeds. In a 45-year study of a sagebrush steppe landscape in Idaho, areas with the highest cover of native species exhibited the greatest resistance to invasion by downy brome (Anderson and Inouye 2001).

BLM Infestations

In 2006, the BLM estimated that nearly 45 million acres of public lands were infested with weeds (Table 3-5). The estimated rate of weed spread on western public lands in 1996 was 2,300 acres per day (USDI BLM 1996). A recent estimate of weed spread on all western federal lands is 10% to 15% annually (Asher and Dewey 2005). The states with the largest weed infestations on public lands are Utah, Nevada, Arizona, and Oregon (Table 3-5). The most dominant invasive plants consist of grasses in the *Bromus* genus, which represent nearly 70% of the total infested area. A single species, downy brome, occupies an estimated 10 million acres alone. Another grass, red brome, has invaded portions of the Southwest. Other important weed species that occupy over 100,000 acres include halogeton, common Mediterranean grass, medusahead, houndstongue, leafy spurge, Canada thistle, saltcedar, spotted knapweed, rush skeletonweed, Russian knapweed, diffuse knapweed, yellow star-thistle, and hoary cress.

The BLM treated approximately 50,000 to 320,000 acres of noxious weeds during 1997 through 2006. Treatments included a combination of chemical, mechanical, manual, biological, and cultural controls, and herbicides have been used to create firebreaks in shrublands as well as improve forage for livestock and wildlife. Each year, over half of the treatment acres were in Montana, and over 35,000 treatment acres were in Idaho. In 2005, the BLM inventoried nearly 6.4 million acres for weeds, and evaluated weed treatments on over 278,000 acres of treatment lands (USDI BLM 2006c).

Non-timber forest products include all plant materials other than timber that are extracted from forests for human use (National Network of Forest Practitioners 2005). They consist of medicinal plants (e.g., ginseng, goldenseal), wild foods (e.g., mushrooms, berries, roots, syrups), decoratives and floral greens (e.g., salal, ferns, boughs), flavors and fragrances (e.g., sassafras, balsam fir), fibers (e.g., cedar bark, sweet grass, lichens), wild native seeds and transplants for restoration and nursery stock, plant dyes, arts and crafts materials, and resins and saps. These forest products are harvested for a variety of reasons, including subsistence, cultural, spiritual, commercial, recreational, and educational purposes.

Native American tribes and Alaska Natives traditionally used forest products for tools, food, construction materials, medicine, and religious ceremonies. Forest products used included bark for housing, branches and stems for utensils and tools, and wood for containers (Chamberlain et al. 1998). Much of the knowledge gained from Native American tribes and Alaska Native groups has influenced the development of the U.S. herbal medicinal industry. A discussion of Native American and Alaska Native plant uses is provided in the Cultural Resources section of this chapter, and in Appendix D of the PER.

During FY 2005, approximately $194,000 worth of non-timber forest products was sold by the BLM. The actual value of non-timber forest products harvested on public lands is substantially greater (USDI BLM 2006c). Over 40% of non-timber forest product sales on public lands were in western Oregon, and about 13% were in Nevada. Other important states for non-timber forest product sales are Colorado and Utah.

Special Status Species

There are over 150 plant species occurring on or near public lands in the treatment area that are federally-listed as threatened or endangered, or proposed for listing. The number may change over time depending on future evaluations of each species' status. BLM policy states that BLM actions must not adversely impact special status species, which include species that are listed under the ESA, given some form of special designation to denote rarity by the state, or are listed as sensitive by the BLM. Special status species, other than those already listed under the ESA, are in potential danger of becoming listed under the ESA. Special status plant species are distributed throughout the western

TABLE 3-5
Estimated Acres of Weed Infestations on Public Lands in 2000

State	Bromus species[1]	Halogeton	Mediter-ranean grass[2]	Medusa head	Centaurea spp.[3]	Hounds-tongue	Other	Total
Alaska[4]	--	--	--	--	--	--	992	992
Arizona	5,007,000	5,000	3,190,600	0	150	0	86,000	8,288,637
California	517,000	4,000	243,000	261,000	35,000	0	69,000	1,129,000
Colorado	1,952,000	372,000	0	0	23,000	408,000	329,000	3,084,000
Idaho	2,814,000	--[4]	0	15,000	214,000	500	376,000	3,419,500
Montana	933,018	300	0	0	157,726	9,580	180,929	1,281,553
Nebraska[4]	--	--	--	--	--	--	--	--
North Dakota	0	0	0	0	0	0	2,196	2,196
New Mexico	30	21	0	0	7,000	0	41,000	48,051
Nevada	6,564,244[5]	1,050,000	1,500,000	5,000	18,100	50	120,000	9,257,394
Oklahoma[4]	--	--	--	--	--	--	--	--
Oregon and Washington	5,139,000	151,000	0	676,000	48,000	113	393,000	6,407,113
South Dakota	208	0	0	0	3	66	2,111	2,388
Texas[4]	--	--	--	--	--	--	--	--
Utah	6,948,000	3,063,000	94,000	25	51,000	604	130,000	10,286,629
Wyoming	1,395,000	1,500	0	0	47,000	27,000	188,000	1,658,500
Total	31,269,500	4,646,821	5,027,600	957,025	600,979	445,913	1,918,228	44,865,953

[1] Includes downy, rigput, Japanese, and red bromes.
[2] This refers to *Schismus barbatus*.
[3] Includes spotted, Russian, diffuse, squarrose, and Tyrol knapweeds and yellow and malta starthistles.
[4] No data were reported for this state.
[5] Acres calculated through GIS based on 10% cover estimate derived from remote sensing data sources. Acreage includes undifferentiated *Bromus* and other invasive annual grass species.
Source: Peterson (2006).

U.S., including Alaska. A list of these species can be found in Appendix J.

For this PER, the BLM has consulted with the USFWS and NMFS since 2001 on listed species and species proposed for listing, and their critical habitats, that could be affected by the proposed treatments. As part of the consultation process, the BLM prepared a *Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Biological Assessment*, which provides a description of the distribution, life history, and current threats for each species (USDI BLM 2007a). Information contained in the BA will be used as a guideline by BLM field offices when developing local projects.

Fish and Other Aquatic Organisms

The BLM administers lands directly affecting almost 155,000 miles of fish-bearing streams and 4 million acres of reservoirs and natural lakes (USDI BLM 2006d). These habitats range from isolated desert springs of the Southwest to large interior rivers and their numerous tributaries.

For this section, the eight geographic regions that were used to describe water resources in the treatment area are used to describe associated aquatic organisms and their habitats (Map 3-5). Key fish species have been identified for each region. These species are ecologically representative of the region(s), use major habitat types within the region, and strongly influence the aquatic community structure. As a result of species distributions and ecological similarities between regions, some key species may occur in more than one geographic region.

Alaska and the Pacific Northwest

The most significant group of native fishes found in Alaska and the Pacific Northwest, in terms of their ecological, cultural, and commercial importance, is the salmonid family. All members of this group, which include salmon, trout, char, and whitefish, require relatively pristine, cold freshwater habitats during part or all of their life cycles, and as such, depend greatly on the conditions of the surrounding forests and rangelands to ensure their survival (Meehan 1991).

Most salmonids use large stream and river systems with direct ocean access. In Alaska, significant streams within public lands include the Colville River and Yukon River systems. The most significant system in Pacific Northwest is the Columbia River Basin. With its headwaters in British Columbia, the Columbia River extends over 1,200 miles to the Pacific Ocean.

Salmonid productivity within a freshwater system is dependent on the underlying stream productivity and the period of use by salmonids during their life cycle. Five general factors determine the suitability of aquatic habitat for salmonids: flow regime, water quality, habitat structure, food (energy) source, and biotic interactions. All salmonids require suitable habitat for spawning, incubation, and rearing. Generally, adults require spawning gravel (less than 2 inches in diameter) and overhead streambank or vegetative cover from predation, while eggs and newly hatched salmon (alevins) require stable gravel and cool (less than 57 °F) and highly oxygenated water (Meehan 1991). Bull trout, which tend to spend most, if not all of their life in inland waters, require water less than 42 °F for spawning and rearing of newly hatched young. Because salmonids prefer cold water, temperatures above 77 °F are lethal to most species in this family (Meehan and Bjornn 1991).

Migrant salmonids pass through several distinct habitats while traveling to and from feeding or breeding habitats, utilizing the full extent of the watershed. The importance of each habitat type differs by species. Chinook salmon, for example, spawn in the mainstem of a river. Upon emerging from the gravel, individuals either start their migration to the sea within their first year (ocean-type) or mature within rivers for 2 to 3 years before migrating to sea (stream-type). In contrast, resident trout populations, such as rainbow, bull, and cutthroat trout, may spend their life (5 to 6 years) in various freshwater systems, including small streams or lakes, and do not migrate to the sea (Meehan and Bjornn 1991).

Various fish species have been introduced into aquatic systems throughout Alaska and the Pacific Northwest. Most of the non-native species have been introduced to promote sportfishing opportunities. Some have escaped from fish farms. Introduced salmonids (such as brook, brown, lake, and hatchery-raised rainbow trout), centrarchids (such as bass and sunfish), and percids (such as walleye) now support many, if not most, of the non-native sport fishing opportunities within these regions (Mills 1994).

A variety of aquatic invertebrates occur in Northwest and Alaskan streams. These species can be quite susceptible to instream activity (e.g., removal of large woody debris), or disturbances in riparian zones. The diversity of aquatic insects is naturally low in glacier-fed streams. Streams flowing through conifer forest, however, support a diverse aquatic invertebrate fauna, including many mayflies, stoneflies, and caddisflies (Whittier et al 1988). The diversity of freshwater mollusks is also usually highest in montane, spring-fed streams and pools (Forest Ecosystem Management Assessment Team 1993).

The Arid Environment

In arid regions, hydrologic inputs that drive aquatic systems come in pulses of short duration. Although rain may trigger biological processes, such as reproduction, after long dry periods, a severe rainfall that creates flash flooding can exert considerable pressure on fish species and community structure (Naiman 1981). The natural hydrology of southwestern desert rivers and streams is highly variable and episodic (Rinne and Stefferud 1997). Natural flow regimes have been considered optimum for sustaining native fish populations (Poff et al. 1997). Although many streams of the U.S. deserts have been highly modified, reducing the impacts of flash floods on fish communities, these sudden rain inputs may still be detrimental. Carrying heavy silt, flash floods may remove or destroy habitat features such as shoreline vegetation, leaving fish species susceptible to rising water temperatures (Naiman 1981).

Because there is limited hydrological connection among water bodies within the desert, fish distribution is also limited. Some streams continually flow through

the humid desert regions, terminating in closed lakes or dissipating in the sand, while other streams originate from subterranean sources, emerging as springs. Springs occur throughout the desert ecosystem, ranging from quiet pools or trickles to active aquifers. Many larger springs emit warm water, with temperatures above the mean annual air temperature, and range from fresh to highly mineralized, carrying large amounts of dissolved materials or extremely low dissolved oxygen levels (Naiman 1981). Although each spring or pool is species-poor, most aquatic inhabitants of each pool are short-lived (1-2 years) and native to only a single locality (Naiman 1981, Page and Burr 1991).

Aquatic species have been introduced into this ecosystem, either on purpose or accidentally, changing the ecological balance to favor many of the non-native species. Invasive fish reduce numbers of native species through competition, hybridization, predation, and the spread of pathogens to which they have developed resistance in their home waters, but to which native species have not (Rinne 1995, 2003). Overall, non-native fish species now outnumber natives in number of species, population density, and often biomass at many localities (Platania and Bestgen 1988; Griffith and Tiersch 1989; Douglas et al. 1994).

Large reservoirs and diversions have been constructed on various rivers and streams, at least partially to deliver irrigation water for agricultural purposes. Additionally, domestic livestock grazing has impacted some rangelands, and historical grazing pressures in riparian areas have reduced the function of some aquatic habitats.

Lower Colorado River and the Rio Grande

These regions cover portions of Nevada, Arizona, New Mexico, and Texas. Grasses and shrubs cover large expanses of the southwest region. This vegetation helps to reduce runoff and erosion during the rainy season. During the dry seasons, dormant vegetation and vegetative litter serve a similar function and are critical for the overall health of these rangeland systems. Livestock grazing in the region has reduced the quality of plant communities, resulting in increased runoff into streams during heavy rainfall, and localized lowering of water tables (Naiman 1981, Rinne and Minckley 1991). These impacts, combined with upper basin modifications, including dams, have impacted fish habitat throughout the lower Colorado and Rio Grande rivers.

The Colorado River, which was once a warm, silted, swift river, is now a cold, clear series of artificial impoundments. These impoundments are a significant threat to desert waterways, and in some instances can end a stream's existence, as has occurred in the lower reaches of the Salt and Gila rivers in Arizona (Cole 1981). The Glen Canyon Dam on the Colorado River, upstream of Lee's Ferry, eliminated the seasonal variation in the river's discharge, ionic composition, temperature, and sediment load in the gorge of the Grand Canyon. The impoundment has altered both the flow of the river and the river's potential for fish habitat downstream. As a consequence, most native fish populations in the Colorado River Basin have declined substantially throughout much of the species' ranges.

The Family Cyprinidae is the most dominant native fish group within the lower basin region, followed by the Family Catostomidae. The Cyprinidae family is composed mainly of minnow species, including the threatened Colorado pikeminnow and bonytail chub, while the Catostomidae family includes the threatened razorback sucker (Starnes 1995). Impoundments have had the greatest impacts on these fish communities (Minckley and Deacon 1991).

Bonytail chubs were historically common, migrating throughout the mainstem of the Colorado River and many of its tributaries, including the Green, Gunnison, Yampa, and Gila rivers, before the construction of large dams (Kaeding et al. 1986). Although bonytails continue to be found in low numbers in several man-made lakes, including Lake Mohave, the temperature and physical and chemical composition of these lakes is very different from those in which the fish evolved (Minckley 1973, Minckley and Deacon 1991).

The headwaters of the Rio Grande River originate in the Rocky Mountains of southwestern Colorado and the river meanders approximately 1,900 miles across Colorado, New Mexico, and Texas before terminating at the Gulf of Mexico. Public lands within the Rio Grande region are limited to the upper and middle reaches of this drainage. Most precipitation in the basin falls as snow near its headwaters or as rain near its mouth, while little water is contributed to the system along the middle reaches of this river, particularly within the Chihuahuan Desert.

Historically, riparian woodlands in the Rio Grande River Valley were a mosaic of various-aged stands dominated by cottonwood and willow (Cassell 1998). However, conversion of much of this land to

residential and agricultural uses has modified this floodplain area, significantly reducing the quantity and quality of wetland and riparian habitat (Cassell 1998; Levings et al. 1998). These changes, combined with instream modifications, have reduced fish habitat considerably throughout the region.

Prior to the construction of dams like the Cochiti Dam, the Rio Grande River had characteristics similar to the Colorado River, and was considered a swift, warm, muddy river (Scurlock 1998). The settling effects of dam reservoirs have resulted in slower, clearer, colder water. This modification of water quality has had a debilitating effect on the range of the Rio Grande silvery minnow, a species that once extended from Española, New Mexico, in the Rio Grande River Valley to the Gulf of Mexico; and in the Pescos River from Santa Rosa, New Mexico, to the confluence with the Rio Grande River in south Texas (Federal Register 1994). Currently, it is found only in a 170-mile reach of the middle Rio Grande River in New Mexico. Much of its decline may be attributed to modification of stream habitat by impoundments, water diversion for agriculture, and stream channelization.

Many non-native fish species have adapted well to the instream modifications to the Lower Colorado and Rio Grande rivers (Maddux et al. 1993; Douglas et al. 1994). Usually more aggressive than native fish and able to outcompete them for resources, these non-native species include walleye, bass (large and smallmouth), and rainbow, brook, and brown trout (Douglas et al. 1994).

Great Basin

The Great Basin covers an arid expanse of approximately 190,000 mi^2 and is bordered by the Sierra Nevada Range on the west, the Rocky Mountains on the east, the Columbia Plateau on the north, and the Mojave and Sonoran deserts on the south. The Great Basin is the area of internal drainage between the Rocky Mountains and the Sierra Nevada Range. Streams in this area never reach the ocean, but are instead confined, draining to the base of the basin, and typically resulting in terminal lakes, such as Mono Lake and the Great Salt Lake, marshes, or sinks that are warm and saline (Moyle 1976).

Many Great Basin fish are adapted to extreme conditions. Trout are predominantly found in lakes and streams at higher elevations within the basin (Behnke 1992). Bonneville cutthroat trout have persisted in the isolated, cool mountain streams of the eastern Great Basin, while Lahontan cutthroat trout populations occupy small, isolated habitats throughout the basin. These trout species are unusually tolerant of both high temperatures (>80 °F) and large daily fluctuations in temperature (up to 68 °F). They are also quite tolerant of high alkalinity (>3,000 mg/L) and dissolved solids (>10,000 mg/L; Behnke 1992).

Water diversions, subsistence harvest, and stocking with non-native fish (particularly rainbow trout) have caused the extirpation of the Bonneville cutthroat trout from most of its range. Although Lahontan cutthroat trout were once common in desert lakes, including Pyramid, Walker, Summit, and Independence lakes, and large rivers, such as the Humboldt, Truckee, and Walker rivers, they have declined in numbers overall, disappearing in many areas (Hudson et al. 2000).

The decline of Lahontan cutthroat trout abundance is a result of habitat loss, interbreeding with introduced rainbow trout, and competition with other species of trout; these factors continue to be the primary threats to the species (Coffin and Cowan 1995, Dunham 1998).

Minnows and pupfish are the dominant fish species at lower elevations and are found in thermal artesian springs and streams (Cole 1981, Feldmeth 1981). Various native and non-native minnows (e.g., dace, chubs, shiners), are common throughout streams and lakes of the basin. Pupfish, however, are very site-specific and live, by choice, at the extreme upper limit of their zone of thermal tolerance (Feldmeth 1981).

Pupfish are able to survive extreme environmental conditions, tolerating water temperatures as high as 115 °F, salinity as high as 142 parts per thousand (ppt; ocean water is typically 33 ppt), and oxygen concentrations as low as 0.13 mg/L (Page and Burr 1991). Because of the high water temperatures, pupfish have developed behavioral traits to regulate body temperature. They have been observed migrating to shallow pools in the morning and remaining there throughout the day, returning to deep water at night. While some pupfish populations are isolated in extremely variable environments (i.e., rapidly fluctuating water levels and temperature gradients), others are isolated in stable springs with constant temperatures (Biological Resource Research Center 2001, NatureServe Explorer 2001).

The most significant problem facing desert fish are the limited water supply. Desert fishes have a tenuous

hold on survival under natural conditions, occurring only in the few permanent springs, rivers, and lakes, and their existence has been placed in doubt by human activities (Deacon and Williams 1991). Pumping groundwater for agriculture has threatened several pupfish populations, including the Devil's Hole pupfish (Deacon and Williams 1991).

Aquatic invertebrates are probably diverse within the Great Basin region, though relatively little is known about them (Hershler and Pratt 1990). Streams flowing within mountainous forest region support diverse aquatic invertebrate fauna including mayflies, stoneflies, and caddisflies. Small springs contain diverse molluscan fauna (Hershler and Sada 1987). Spring biotic communities are usually less diverse than stream communities, and springs are often habitat for endemic species because they are predictable, benign habitats that have served as refugia during dry periods.

The Upper Colorado River Basin

The Colorado River is the primary river of the southwestern U.S., draining approximately 242,000 mi^2 from portions of Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, and California. The headwaters of the Colorado River are located in Rocky Mountain National Park in Colorado, from which the river flows southwest, toward the Gulf of California.

The Colorado River Basin is divided into two basins, the Lower and Upper basins, with a dividing line near Lee's Ferry, Arizona. Three distinct aquatic zones have been identified in the Upper Colorado Basin (Joseph et al. 1977). The upper (headwater) zone is characterized by cold and clear water, a high gradient, and a rocky or gravel substrate. Resident salmonid populations are predominant in this zone. An intermediate zone occurs as the stream flows out of the upper zone. Within the intermediate zone, water discharge rates and temperature increase, and water is turbid during spring runoff and after heavy rainfall. The substrate is generally rocky with occasional expanses of sand. The lower (large-river) zone has warm water, meandering sections, and a low gradient in flat terrain. Minnows and suckers are the dominant fish communities of the intermediate and lower zones.

The construction of reservoirs, such as Fontenelle and Flaming Gorge, has had profound effects on water flow and quality throughout the upper basin region; lower summer water temperatures have resulted, and spawning of native fish has virtually ceased (Carlson and Carlson 1982, Wullschleger 2000). The humpback chub, for example, prefers deep, fast-moving, turbid waters often associated with canyon-bound segments of the rivers (Valdez and Clemmer 1982). Historically, this species occurred in great numbers throughout the Colorado River system from the Green River in Wyoming to the Gulf of California in Mexico. Today, due to lower water temperature and migration routes blocked by dams, this species can only be found in limited deep, canyon-bound portions of the Colorado River (Douglas and Marsh 1996).

Native salmonids in the upper zone of the Upper Colorado River Basin are disappearing with the introduction of rainbow, brook, and cutthroat trout for sport fishing (Miller et al. 1982). The habitat immediately downstream of constructed reservoirs favors these non-native salmonids (Platania 2003). In addition, non-native species effectively outcompete native species for available resources, and interbreed with native species (Joseph et al. 1977; Rinne and Minckley 1991). Populations of native species within lakes are also declining as a result of competition with and predation by, introduced non-native species, such as carp, northern pike, and red shiner (Rinne and Minckley 1991).

California

California has two distinct fish habitat regions: northern and southern California. The northern region extends from the Oregon border south to Sacramento (the most southern reaches of salmon distribution in North America). This region includes rain-fed coastal streams, snow-fed streams of western Sierra Nevada, and the Central and San Joaquin valleys. Habitat characteristics are very similar to those observed in the western Pacific Northwest, with a dominance of evergreen forests throughout the area. Streams in the coastal region usually have steep drainages and are characterized by extreme seasonal flow, flooding in the winter and becoming intermittent in summer (Moyle 1976). Water flow in snow-fed streams is more constant than in coastal streams, a condition to which native fish are adapted.

Fish habitats within southern California are located predominantly within the arid southeast region of the state, and include numerous rivers and lakes. Native fish communities, such as those comprised of pupfish and minnows in the lower elevations and cutthroat

trout in the mountainous regions, and their aquatic habitats, exhibit characteristics similar to those seen in the Lower Colorado and Great Basin regions.

Missouri River Basin

The Missouri River Basin encompasses 529,350 mi^2 and flows for over 2,340 miles, from its headwaters at the confluence of the Gallatin, Madison, and Jefferson rivers in the Rocky Mountains at Three Forks, Montana, to its confluence with the Mississippi River at St. Louis, Missouri.

The Missouri River historically carried a heavy silt load, collected from tributaries in the northern part of its drainage. Its wide and diverging channel created shifting sandy islands, spits, and pools, resulting in fish species suited to its turbid and dynamic conditions. Many of the fish species within the upper reaches of the Missouri River are considered benthic fishes, such as sturgeon and minnows (Duffy et al. 1996; Scarnecchia et al. 2002).

Public lands in Montana occur predominantly in the northeastern portion of the state. The surrounding habitat, referred to as the Milk River Basin, has relatively high densities of depressional wetlands dominated by shortgrass prairies. The upper reaches of the Missouri River and its major tributaries maintain the healthiest fish populations in the basin (White and Bramblett 1993). However, dams built along the mainstem of the Missouri River, such as the Fort Peck Dam in Montana, have limited fish migration patterns and water flow, as well as the movement of silt downstream, resulting in declining fish numbers and reduced quality spawning and rearing habitat (Hesse et al. 1989). This combination of habitat loss and poor dam management has contributed to the decline of many native mainstem species including paddlefish, sturgeon, and several species of chub.

Native species such as the sicklefin chub, sturgeon chub, and pallid sturgeon prefer silty rivers with a diversity of depths and velocities forming braided channels, sand bars, sand flats, and gravel bars, all of which were historically common along the Missouri River (Gilbraith et al. 1998; Scarnecchia et al. 2002). All three species have been affected by changes in the Missouri River. Although the chub species have managed to effectively reproduce where habitat conditions allow, the pallid sturgeon has been unable to adapt well to the present river conditions, resulting in a significant decline in its abundance (Duffy et al. 1996). The endangered pallid sturgeon, a bottom feeder, may become extinct, as changes in water flows continue to affect food sources, spawning habitat, and the timing of reproduction (USFWS 1990).

Introduced species, such as rainbow trout, have been stocked throughout Montana. Rainbow trout have adapted well to the wide range of habitats available within the basin. The species has successfully integrated into this aquatic system, and has caused a severe reduction in the range of native cutthroat trout through hybridization and competition (Walleyes Unlimited 2002). Other introduced species that have adapted well to the modifications of the Missouri River drainage in Montana include smallmouth bass, walleye, and white crappie.

The Missouri River drainage includes all of Wyoming east of the Continental Divide, and represents 74% of the state's surface area. Typically, streams along the southern boundary of Wyoming originate from the mountainous region of northern Colorado and are characterized by high gradients, cobble and boulder substrates, and riparian areas dominated by conifers and willows. This area of Wyoming drains into the North Platte River drainage, comprising 24% of the surface area of Wyoming. Native and introduced salmonids such as rainbow, brook, and cutthroat trout dominate fish communities within this region.

As streams flow onto the arid, desert plains, they are characterized by low gradients, meandering or braided channels, and silt, sand, and gravel substrates, with riparian areas dominated by cottonwoods, willows, shrubs, and grasses. Central and northern Wyoming are considered high cold desert. Native and non-native minnows and suckers dominate fish communities.

Special Status Species

There are over 100 aquatic animal species occurring on or near public lands that are federally listed as threatened or endangered, or are proposed for future listing. Included in the total number are 59 species/subspecies of fish, 13 species of mollusk, and 6 aquatic arthropods. A complete list of these special status species may be found in Appendix J. Please note that this list is dynamic, and will likely change throughout the time period considered by this PER.

Special status aquatic animal species are found on public lands throughout the United States. A number of listed salmon populations are found in rivers of the Pacific Coast states. In arid habitats, many special

status fish species are found in the rare and fragile desert wetlands and springs, as well as in the major rivers such as the Colorado and the Rio Grande. In the deserts of the Great Basin and Colorado Plateau, terminal lakes, marshes, and sinks provide important habitats for special status fish species that are adapted to their warm, saline conditions.

Special status mollusks occur predominantly in the Snake River of Idaho, and in thermal habitats and small springs and wetlands in New Mexico, Arizona, and Utah. Aquatic arthropods of special concern occur predominantly in the vernal pools of California.

Wildlife Resources

Public lands sustain an abundance and diversity of wildlife and wildlife habitat. Public lands provide a permanent or seasonal home for more than 3,000 species of amphibians, reptiles, birds, and mammals.

Wildlife populations are found in areas where their basic needs—food, shelter, water, reproduction, and movement—are met. The area in which the needs of a particular population are met is its habitat. Many animals have special behaviors and physical traits that allow them to successfully compete with other animals in only one or a few habitats; many threatened and endangered species fall into this category. Other animals, such as mule deer, coyote, and American robin are less specialized and can use a wider range of habitats.

Several features make some habitats better for wildlife than others. In turn, the more of these features that are present, the greater the diversity of wildlife species that is likely to be present. These features include:

- Structure – shape, height, density, and diversity of the vegetation and other general features of the terrain.
- Vertical layers – layers of vegetation (e.g., herbaceous, shrub, and forest canopy).
- Horizontal zones – vegetation and other habitat features that vary across an area.
- Complexity – an integration of vertical layers and horizontal zones.
- Edge – the area where two types of vegetative communities meet, such as a forest and shrub community.
- Special features – unique habitat features needed for survival or reproduction, including snags (dead trees), water, and rock outcrops.

Of the 164 million acres of rangeland administered by the BLM within the western states, 52% have been inventoried for habitat quality. Of those acres, 42% are rated as excellent or good, 42% are rated as fair, and 16% are rated as poor based on the departure of vegetation composition from a reference condition (USDI BLM 2006d). The BLM also administers 55 million acres of forestlands and woodlands. Of these acres, 16% have been rated as healthy and providing good habitat for wildlife, while 25% are in need of restoration, including mechanical thinning, fuels reduction, and prescribed fire. The condition of the remaining acres is unknown (USDI BLM 2004a).

An important activity of the BLM is to manage vegetation to improve wildlife habitat. Plants, which are an important component of habitat, provide food and cover. Food is a source of nutrients and energy, while cover reduces the loss of energy by providing shelter from extremes in wind and temperature, and also affords protection from predators. The following section describes the important characteristics of wildlife and habitat in the eight ecoregions that comprise the treatment area, focusing primarily on the vegetative characteristics of habitat and how wildlife use this vegetation.

Tundra Ecoregion

Because of the short growing seasons and low summer temperatures, vegetation in tundra areas exhibits simple structure, few layers, limited complexity, low primary productivity, low decomposition rates, low stress tolerance, and high susceptibility to physical disturbance. Thus, on an annual basis, the tundra supports fewer wildlife species and numbers than other ecoregions, although it does support large populations of some wildlife, such as shorebirds and waterfowl, during summer.

Wildlife species in tundra habitats fall into three categories: 1) resident species that remain active year-round, 2) resident species hibernating in winter, and 3) migratory species present for only a portion of the year (Lent 1986). Resident species that remain active year-round include the willow ptarmigan, common raven, snowy owl, Arctic fox, brown lemming, muskox, and caribou. Hibernating species include the

Arctic ground squirrel, and hoary marmot. The great majority of the 97 or so bird species using the tundra are migratory (Pitelka 1979).

Except for the wood frog, there are no amphibians or reptiles in the Tundra Ecoregion. Because they are cold-blooded animals, the climate is too cold for these groups. Wood frogs are unique in that they partially freeze in winter; up to one-third of the water in a wood frog's body may turn to ice for a period of several weeks (Behler 1995).

The tundra has low species diversity; tundra insect fauna, for example, is only 1% to 5% as rich in species as the insect fauna found at temperate latitudes (Bolen 1998). Wildlife populations are also constrained by the low plant productivity, and can fluctuate greatly in response to annual changes in plant productivity. Animal population peaks can markedly alter vegetation and other habitat features in some instances, leading to sharp declines in population numbers. The brown lemming is the classic example of a cyclic species, with extreme fluctuations in numbers. Lemmings clip and consume large amounts of dormant vegetation under the snow during winter. During periods with large populations of lemming, lemmings remove much of the vegetation during winter, resulting in limited food during summer, and also limited protective cover against predators. As lemming populations decline due to starvation and predation, species that prey upon lemmings, such as the snowy owl and Arctic fox, also show marked population declines.

The widespread occurrence of shallow lakes and wetlands during the summer creates ideal conditions for insects, especially mosquitoes. Mosquitoes have adapted to the harsh winter by overwintering in an egg stage that is resistant to drying, hatching as larvae when warmer weather and moisture returns in the spring. Plant-eating insects are rare in the Tundra Ecoregion, likely due to the low growth rate of the vegetation. Nearly all insects prey on animals, biting the animal or burrowing into its skin or flesh.

Insect fauna provides an important prey base for migratory shorebirds and waterfowl. To cope with the short summer and limited food supplies, migratory birds tend to nest almost immediately upon arriving on the breeding grounds, and young hatch when insects and vegetation are most abundant. Waterfowl, other small birds, and small mammals are preyed upon by Arctic fox, snowy owl, gyrfalcons, peregrine falcons, and rough-legged hawks (World Wildlife Fund 2002).

Even resident populations of the tundra can be quite mobile in their search for suitable food and cover. Arctic foxes may travel hundreds of miles in search of new denning areas, while caribou may go years without using certain winter ranges. Ptarmigan congregate by the thousands in favorable winter valleys in winter, but disperse widely during the summer.

Suitable habitat for denning or burrowing species may be limited in areas with continuous or near-continuous permafrost. Burrowing species must select areas where the permafrost is not near the surface. The presence of deep snowdrifts is important for denning wolverines, polar bears, and brown bears. Talus slopes and cut banks are important habitat features used by denning Arctic foxes. Raptors tend to nest along river and coastal bluffs because of the generally flat, treeless character of the Arctic tundra.

Subarctic Ecoregion

The Subarctic Ecoregion, or boreal forest, is the largest ecoregion in North America. The vegetation is similar in structure and dominated by relatively few species of spruce, firs, larch, and other conifers, and some hardwoods such as birch and aspen. Boreal forests are structurally more complex than tundra, and thus support a greater diversity of wildlife species. These forests provide habitat for large mammals, such as grizzly bear, black bear, wolf, moose, and wolverine; small mammals, such as red fox, American beaver, American marten, and weasels; birds, such as spruce and ruffed grouse, owls, and raven; and the amphibian, wood frog.

Many species have unique adaptations to survive in subarctic forests. Herbivores typically graze on herbaceous and shrubby vegetation during the summer, but shift to a high fiber diet of conifer needles and woody shrub browse during winter.

White-winged crossbills are an example of a species that have adapted to the abundant cone seeds in boreal forests. These birds move in large flocks when cone supplies are abundant, but are nomadic when cone supplies are limited. White-winged crossbills also breed opportunistically, when cone supplies are most abundant.

Bog vegetation occurs widely throughout the Subarctic Ecoregion. Bogs are characterized by a spongy underfoot of peat that provides a rooting layer for most vegetation, and is often overlain by

sphagnum moss. In Interior Alaska, bogs are often underlain by permafrost. Bogs tend to have limited structural complexity, as trees and shrubs are often sparse in bogs. Thus, fewer wildlife species are found in bogs than upland forests. The high water table of bogs also discourages burrowing species.

Fires, which are normal, recurring events in boreal forest ecosystems, help maintain ecosystem productivity and biodiversity (Rowe et al. 1974; Adams et al. 2000). Large area fires are common due to the uniformity of the vegetation and presence of a continuous layer of surface fuels, the moss and lichen layer. Fires can also destroy the rich growth of lichens found in the northern portions of the boreal forest. These lichens are an important food source for barren-ground caribou, comprising 60 to 80% of the winter diet of caribou (Boertje and Garner 1998, Bolen 1998). Fire may be necessary to maintain lichen ranges in the long term, because in old stands, competition from sphagnum moss, shade from trees, or the old age of lichens may limit lichen productivity (Andreev 1954, Viereck 1973, Zoltai 1974, Maikawa and Kershaw 1976).

After a fire of adequate severity, birch, aspen, and willow can revegetate the area, either sprouting from surviving roots or establishing from seed where adjacent seed sources exist. Willow, in particular, is the mainstay of the moose's winter diet, and moose populations thrive in such burned areas. However, because lichens are slow growing, it can take decades before the biomass of lichens for winter caribou grazing reaches its preburn levels (Joly et al. 2002). Schaefer and Pruitt (1991) observed that burned areas did not provide suitable winter habitat for caribou, but that fires could enhance the quality and abundance of summer forage.

Temperate Desert Ecoregion

Vegetation structure in the Temperate Desert Ecoregion tends to reflect the area's precipitation pattern and temperature regimes (Jones 1986). Sagebrush is co-dominant with perennial bunchgrasses in the wetter, northern part of the ecoregion, but sagebrush dominates in the southern, drier portion (Paige and Ritter 1999). Trees are mostly limited to the pinyon-juniper woodlands found at higher elevations, and along watercourses.

Northern, cooler desert regions, such as the Great Basin Desert, support far fewer wildlife species than southern, warmer deserts found in the Subtropical Desert Ecoregion (Bender 1982, Brown 1982). The shorter growing season of the northern deserts results in lower plant productivity and a lower diversity and abundance of animal prey. Thermal regimes in northern deserts also limit the activity of wildlife, especially cold-blooded animals such as amphibians and reptiles, to short periods each year.

The Great Basin Desert, which is the largest desert in North America, is dominated by two structurally and floristically simple plant communities—sagebrush and saltbush. Because most precipitation in the region falls during the winter when plants are dormant, there is insufficient moisture during the growing season for the development of plant structure and diversity needed to support an abundance of wildlife species. This desert supports large populations of pronghorn antelope, and also provides critical habitat for sage-grouse species that use sagebrush for food and cover.

Desert habitats have some of the most unusual wildlife in the treatment area. Desert animals are adapted to survive under extreme environmental conditions, including low, erratic rainfall, and highly variable temperatures. Many small desert mammals require no free water, but survive on their own metabolic water and through water conservation measures, such as being active only at night and excreting uric acid rather than urea. Spadefoot toads have a special appendage on their hind foot that allows them to burrow into the soil to avoid daytime heat, and breeding activities are timed to occur during periods with summer thunderstorms.

Special features, such as water and rock outcrops, are critical habitat components in desert environments. Permanent and temporary water sources are scarce in this ecoregion, but their importance cannot be overstated. Riparian areas are especially important in the desert. For example, of the 148 species of breeding birds in the Great Basin Desert, 131 are dependent upon riparian areas for all or part of their life requisites.

Talus slopes, cliffs, and rock outcrops provide nesting and feeding habitat, thermal and escape cover, and resting sites for wildlife. Common reptiles that use these features include the common garter snake, western rattlesnake, and sagebrush lizard. Rodents and other small mammals use rock features to hide from predators, and to avoid temperature extremes. Bats use caves and rock outcrops as roost and nursery sites. Deep, rugged cliffs are used by desert bighorn sheep

for lambing, escape, and thermal cover. Raptors, including golden eagles and several species of hawks use cliffs and rock outcrops as nest and perch sites. The canyon walls of the Snake River provide nesting habitat for one of the highest densities of predatory birds in the world (USDA Forest Service and USDI BLM 1997).

Soil characteristics determine the number of subsurface sites available to wildlife in the desert. Lack of vegetative structure in deserts is often offset by subsurface space created by deep and diverse soils. Subsurface sites provide shelter from daytime heat, protection from predators, and sources of food for predator, such as snakes.

Wildlife habitat in this ecoregion has undergone great change during the past century, usually to the detriment of native species. For example, cool-season bunchgrasses once dominated large areas of the Columbia Plateau. Much of the grassland community has since been lost with the conversion of lands to agricultural and urban uses. Changes in fire regimes and grazing by domestic livestock have modified significant portions of the remaining grassland habitat. Species associated with native perennial bunchgrass communities, including the Columbian sharp-tailed grouse, kit fox, and Idaho ground squirrel, have declined in numbers more than other species' groups in the region. These species rely on grassland vegetation for plant and insect forage, nesting and brood-rearing habitat, and hiding cover.

Much of the sagebrush habitat in the Temperate Desert Ecoregion has been lost or modified during the past several decades, resulting in habitat fragmentation. This loss is a result of conversion to agricultural and urban uses, grazing, altered fire regimes, and the encroachment of downy brome, other weeds, and woody species such as juniper and Douglas-fir (USDA Forest Service and USDI BLM 1997). The best sagebrush habitat occurs where there is a mix of multi-age sagebrush with associated perennial bunchgrasses and forbs, interspersed with open wet meadows or riparian areas. These are key habitat components for sage-grouse and other wildlife. During winter, sage-grouse feed almost exclusively on the leaves of sagebrush (Patterson 1952; Wallestad et al. 1975).

Subtropical Desert Ecoregion

The Subtropical Desert Ecoregion is composed of the Mohave, Sonoran, and Chihuahuan deserts. In contrast to the cooler deserts of the Temperate Desert Ecoregion, the hotter deserts of the Subtropical Desert Ecoregion tend to have a more diverse flora and fauna. The northern limits of many species common in Mexico are found in this ecoregion, such as brown-crested flycatcher, vermilion flycatcher, black-tailed gnatcatcher, hooded skunk, pocketed free-tail bat, coatimundi, and jaguar. The Sonoran Desert is the most floristically diverse of the three deserts, and as a result, has the greatest diversity of wildlife. The desert tortoise, which is federally listed as a threatened species (in the Mojave Desert only), is found in this ecoregion. Long-lived and once common, desert tortoises have suffered population declines due to adverse impacts associated with human activities (USFWS 1994a).

The ecoregion is characterized by widely dispersed desert plants that provide little ground cover for wildlife. Canopy cover rarely exceeds 50%, and there is usually extensive bare ground between plants. In the Mojave and Sonoran deserts, several species of cacti, ocotillo, yucca, and other woody species provide areas of near-woodland habitat that support a greater diversity of wildlife than other areas with less plant structure.

Like species in the Temperate Desert, wildlife in the Subtropical Desert have evolved numerous means to deal with water scarcity and other rigors of the hot desert. Presence of standing water in winter and new herbaceous growth in spring provide water and forage for most wildlife (Laudenslayer and Boggs 1988). During summer and fall, some species, such as the desert kangaroo rat and other rodents, derive water from the seeds in their diet. Saguaro, as well as most other species of cactus, has spines for protection from many grazing animals. However, collared peccaries and many desert rodents can avoid or digest cactus spines and obtain water from the plants' succulent tissues.

Black-throated sparrows secrete highly-concentrated urine and dry feces, and thus need little drinking water. In contrast, most other desert-living bird species show few adaptations for coping with water scarcity and simply fly to water sources to meet their needs. Reptiles and small mammals are active mostly at night and retreat to cool burrows, or seek shelter

under vegetation or in rock outcrops to avoid the midday sun and reduce water loss. The yucca night lizard, for example, is restricted to desert regions with downed litter of yucca and agave plants (Jones 1986).

Salt balance is an important physiological function in desert animals. Chuckwallas, desert lizards, eat the fleshy tissue of cacti, and are able to excrete salt from their nostrils by sneezing, without losing much water. Many other lizard species also have salt glands for excreting salt.

The structure of live vegetation is probably the most important habitat feature in these deserts. Shrubs and tall cacti are used by lizards for feeding and breeding, and lizards climb onto creosote bushes during the day to avoid hot ground temperatures. Vertical structure provides nesting, feeding, and breeding niches for birds. Cacti provide roosting and breeding habitats for bats that small shrubs do not provide. Horizontal vegetation structure is also important, as some species of birds prefer either open or closed habitats, and many species of lizards require more open areas for foraging, but closed habitat the rest of the time to avoid the heat and predators (Pianka 1966, Rottenberry and Wiens 1980).

The extensive root systems of certain desert plants, such as creosotebush, provide access to subsurface openings for toads, salamanders, lizards, snakes, and small mammals. Creosotebush areas found in the Chihuahuan and Sonoran deserts have little vegetative structure, but have a rich diversity of wildlife because of favorable soils that allow access to subsurface space.

Desert wildlife have evolved characteristics that are adaptive to the attributes of certain plant species. Desert iguanas feed heavily on creosotebush buds, especially during the spring, and their distribution is closely related to the distribution of creosotebush (Norris 1953). Several birds rely on the saguaro and other cacti for roosting and nesting, including elf owl, cactus wren, and gilded flicker. Cavity-nesting birds often select vegetation with spines, perhaps to discourage nest predation by small mammals and reptiles. The Gila woodpecker and gilded flicker both excavate nest cavities in saguaro cacti, but due to differences in bill structure, the gilded flicker must excavate its cavity near the top of the cactus, while the Gila woodpecker can excavate cavities near the base of the trunk.

Temperate Steppe Ecoregion

The Temperate Steppe Ecoregion is comprised of prairie grasslands, evergreen and deciduous forests, and sagebrush and chaparral shrublands. Prairie grasslands occur in an environment with irregularities in weather patterns, including wet and dry spells, which occur often enough to impose severe stresses on wildlife. In a drought year, for example, reduced moisture and higher temperatures can greatly affect the abundance and quality of vegetation used for food and cover, often leading to substantial population declines in some species, especially birds.

The characteristics and habitats of grassland animals differ from those of animals that inhabit shrublands and forests. Many grassland species live in burrows, including burrowing owls, prairie dogs, ground squirrels, pocket gophers, black-footed ferrets, and American badgers. Burrows provide a place to hide from predators, a more stable microclimate during hot summers and cold winters, and shelter from grassland fires (Brown 1982).

If an animal cannot hide in a burrow, it must be a fast runner to avoid predation. The swift fox can travel at 25 miles per hour (mph), while the pronghorn can run at 70 mph. Even quail and grouse often run instead of flying to escape predation, staying close to the ground and using the vegetation as cover.

Grassland animals tend to occur in large social groups. For example, millions of American bison occurred on the Great Plains in presettlement days and millions of prairie dogs have been found in a single prairie dog town. Wildlife species living in grasslands tend to be more social than their forestland counterparts. Prairie dogs live in large, highly organized social units, while their eastern woodland counterpart, the woodchuck, rarely interacts with its own species. Flocking species are also more prevalent in grasslands than in forestlands. Socialization enables the members of a flock to more readily detect predators, but also to convey other information, such as mating status, which is difficult to ascertain in open grassland where sound is muffled and perches are few. Raptors are also more common in grasslands than other habitats, as open spaces favor animals with good vision and provide an abundance of prey items.

Compared with other habitats, grasslands tend to have low bird species diversity and abundance (Wiens and Dyer 1975). Although grasslands are highly

productive, they are structurally simple and less complex than other habitat types, and thus provide birds with few niches to exploit. Bird species tend to differentiate themselves based on the cover and height of the grassland vegetation, with the horned lark and burrowing owl selecting areas with low, scattered vegetation, and the savanna sparrow and bobolink selecting high, dense herbaceous cover.

Grasslands found in the proposed treatment area include the Great Plains, shortgrass prairie, intermountain grasslands, and the Palouse grasslands. The mixed prairie of the Great Plains constitutes the eastern range for many grassland animals, including the prairie dog, pronghorn, swift fox, and desert cottontail. It was also the home of the American bison. The shortgrass prairie to the west of the Great Plains, and east of the Rocky Mountains, is where true grassland animals are found. Many of the species found here cannot survive in the tallgrass and mixed prairies because they are less able to see and flee from predators.

Wildlife found in the intermountain grasslands associated with the Rocky Mountains are similar to those found in grasslands to the east, except species that need a year-round supply of green grass do not occur. Deer, elk, and pronghorn survive in the intermountain grasslands by foraging upon shrubs and other woody vegetation during winter. Ground squirrel diversity is especially high in the intermountain grasslands, with 19 of the 22 species of ground squirrels in North America found in this region. Much of the Palouse grasslands have been converted to agriculture or lost to shrubland encroachment, greatly reducing their value to sharp-tailed grouse and other wildlife that were once common.

Evergreen and deciduous forests are found at higher elevations and along streams and other aquatic areas. The plant species composition of coniferous forest stands, and the types of wildlife that use them, varies with altitude. Aspen is an important component of many deciduous forests. Aspen typically is found in moist areas and becomes established after fire or other disturbance has cleared a suitable area. American beaver use aspen limbs and foliage for food and to build dams and lodges. Snowshoe hare feed on aspen twigs and bark during winter, and aspen buds are important in the winter diet of ruffed grouse. American badger, ground squirrels, and other burrowing animals provide bare ground needed by aspen seeds to germinate.

Subtropical Steppe Ecoregion

The Subtropical Steppe Ecoregion is composed primarily of grassland vegetation, with local occurrences of shrubs and woodlands. Grassland wildlife species found in the Temperate Steppe Ecoregion are also found here, such as pronghorn, mule deer, white-tailed deer, coyote, American badger, and black-tailed jackrabbit. The northern limit of distribution of several mammals, including the Mexican ground squirrel and gray fox, occurs in the grasslands of this ecoregion (Bailey 1997).

Woodlands formed of pinyon and several species of juniper (pinyon-juniper woodlands) are found on about 4 million acres, and are also found in other ecoregions. The canopy of these woodlands is generally open, and the trees are far apart. Open stands of pinyon-juniper with abundant vegetation below the trees provide the best wildlife habitat. These woodlands generally do not have the structure and complexity to support a large diversity of wildlife as compared to other forest types, although a study in Utah showed that avian species diversity in pinyon-juniper woodlands is similar to species diversity in other woodland and forest types (Paulin et al. 1999).

Reptiles are not common in pinyon-juniper woodlands. Birds feed on pinyon and juniper seeds and berries, find nesting cavities within juniper trunks, and use the stringy and fibrous juniper bark for nesting material. The pinyon jay, plain titmouse, and bushtit are obligate to these woodlands, and 144 different species of birds have been observed in pinyon-juniper woodlands in New Mexico (Short and McCulloch 1977). Avian species diversity is usually greater in pinyon-juniper woodlands than in adjacent grasslands (Sieg 1991).

Abert's squirrel, pinyon mouse, wood rat, gray fox, and other small mammals eat berries, seeds, and the inner twigs from pinyon-junipers. Mule deer, white-tailed deer, elk, pronghorn, and desert bighorn sheep may occur throughout the year in pinyon-juniper woodlands. Leaves and berries of pinyon pine and juniper trees are eaten by large mammals.

Most food habit studies have shown that the value of pinyon-juniper woodlands to wildlife is usually related to the quantity and composition of the vegetation growing in association with pinyon-juniper. As pinyon-juniper stands mature, the trend is toward increased tree density and finally, dense canopy cover.

The dense canopy cover shades out plants found below pinyon-junipers, reducing the variety of plant types that can provide food and cover for wildlife. Small mammals, deer, and elk use of pinyon-juniper woodlands declines as tree canopies become more dense, although some species, like pinyon mice and pinyon jays, may favor denser stands (Short and McCulloch 1977, Willis and Miller 1999).

Mediterranean Ecoregion

The vegetation of the Mediterranean Ecoregion is dominated by grassland, shrubland, and forestland habitats. Many shrub (chaparral) and forest/woodland plant species have thick, hard, evergreen leaves. The number of wildlife species using shrub habitats is limited by the lack of trees in shrublands. However, wildlife species diversity can also be limited in evergreen woodlands due to the paucity of shrubs in these communities, as shrubs are often unable to compete with trees for the limited moisture.

Because of their tough, leathery texture, the leaves of vegetation in chaparral communities are resistant to wilting, and thus provide cover for wildlife even during the frequent droughts typical of the region. Wildlife found in chaparral tend to be species that nest on the ground or in shrubs, such as ground- and shrub-nesting birds and rodents, or that prey upon ground- and shrub-dwelling species, including coyote, striped skunk, and bobcat.

Although this ecoregion supports a diverse vertebrate fauna, including numerous species of reptiles and rodents, only a limited number of species are closely tied to the chaparral. These include the mountain quail, California thrasher, wrentit, brush rabbit, California mouse, and dusky-footed woodrat.

Mountain quail favor slopes covered with chaparral. They feed on acorn mast, fruits, and seeds in the fall, leafy foods during winter, and bulbs in the spring and summer. Thrashers and wrentits find good food and cover in the chaparral, and are more often seen than heard in the dense vegetation. The brush rabbit does not use burrows regularly like most other species of rabbits, perhaps because of the dense chaparral cover. Woodrats construct stick dens that are also used by the California mouse. Since homes are constructed of sticks, woodrats are vulnerable to fires in chaparral communities.

Chaparral communities are adapted to fire, and wildlife respond by retreating to burrows, hiding in rock crevices, or escaping from the area. After a fire, seed-eating birds, such as mourning doves, move into the area to feed on seeds exposed by fire. Mule deer seek out the temporary community of herbaceous plants that develop during the first year or two after the fire. Many of these plants produce bright flowers that attract nectar-feeding insects and birds.

Deciduous and evergreen woodlands provide vegetation structure and complexity that benefits a variety of wildlife species. The habitat often occurs in a mosaic-like pattern of conifer stands intermixed with deciduous tree stands. The shrub and herbaceous strata are often poorly developed in these woodlands. Mature woodlands are important to cavity nesting birds, and oak mast crops are an important food source for birds and mammals, such as scrub and Steller's jays, acorn woodpecker, wild turkey, mountain quail, California ground squirrel, western gray squirrel, black bear, and mule deer (Anderson 1988). Amphibians that reside in the forest detritus layers include Mount Lyell salamander, ensatina, and relictual slender salamander (McDonald 1988).

Oak woodlands serve as important wildlife habitat, supporting over 300 vertebrate species, many of which are special status species such as the California spotted owl and willow flycatcher (Thomas 1997). Oak trees provide nesting sites for both canopy- and cavity-nesting birds, and the acorns they produce are an autumn food source relied upon by many bird and mammal species (Almeda County Agriculture Advisory Committee 2005).

Annual and perennial grasslands are found in central and coastal California. Annual grassland habitats consist largely of non-native annuals that have displaced native perennials (Kie 1988). Habitat structure and wildlife abundance are dependent on a mix of plant species at a site. Sites with western brackenfern exhibit a taller, more diverse structure than sites with shorter grasses. Many wildlife species use grassland habitats, but some require special habitat features, such as cliffs, caves, ponds, or shrubby areas for breeding, resting, and escape cover.

Marine Ecoregion

The Marine Ecoregion is dominated by evergreen and, to a lesser extent, deciduous forests located along the Pacific Coast. These forests are managed by the BLM primarily for timber production and wildlife habitat.

Temperate forests are among the most productive habitats in the world (Whittaker 1975). The energy available to wildlife from temperate forests vegetation, along with their structure and complexity, provide habitat for a diversity of wildlife. Temperate forests are also routinely subject to disturbances that increase variability in the environment and create edge habitat. In turn, the succession of vegetation types that follow a disturbance provide habitats for a succession of wildlife species.

In general, deciduous trees support more wildlife than evergreen trees (Glenn-Lewin 1977). Conifer forage is less palatable than deciduous forage, which means that there are fewer animals that can consume the foliage, and in turn, be consumed by predators. Conifer foliage is also relatively unpalatable to decomposing organisms, such as fungi and bacteria, so the decomposition of coniferous matter is often a slow process (Hunter 1990). Deciduous trees generally have more structural complexity than conifers, providing more places for animals to feed and seek shelter.

Conifers do possess characteristics that are critical to the survival of many wildlife species. Spruce grouse are dependent on conifer foliage to survive the winter. Conifer stands also provide crucial winter cover to elk, deer, and other wildlife by blocking wind and keeping snow from reaching the ground, covering browse, and restricting animal movements. However, the foliage that captures snowfall also intercepts light in the spring, reducing the amount of light that can reach the forest floor, warm the soil, and stimulate the growth of herbaceous vegetation and shrubs used by these wildlife.

Since this ecoregion is characterized by abundant rainfall, there is an abundance of moisture on the forest floor, as well as in ponds and streams, to support a diversity of amphibians. All frogs and toads in this region lay their eggs in water. Most salamanders lay their eggs in or near water, while others lay their eggs on land under logs (Ensatina), in rock outcrops (western red-backed salamander), or both (clouded salamander). Many of these amphibians spend a portion or most of their lives out of water, living under moist logs, dead wood, or forest litter, or in burrows or root or rock crevasses.

Few reptiles are found in this ecoregion. The alligator lizard is the only widely distributed species found in forested habitats, and the painted turtle and western pond turtle are the only turtles common in the area. The most common snake is the northwestern garter snake.

Birds have adapted to exploit the different layers of vegetation in the forest. Ruffed grouse, winter wren, American robin, spotted towhee, and dark-eyed junco are often found near the forest floor or in shrubs. Woodpeckers and brown creepers are seen moving up and down the trunks of trees in search of insects. Nuthatches and chickadees exploit the cone seeds, while warblers and kinglets glean insects from the upper deciduous forest canopy.

Like birds, mammals exploit the vegetation types and strata found in the forest. Shrews, mice, and moles are fossorial or live near the forest floor. Rabbits and hares reside near the ground and seek shelter in dense herbaceous or shrub vegetation. Wide-roaming species that live near the ground include black-tailed deer, elk, black bear, mountain lion, and bobcat. Deer and elk tend to remain in dense forest stands during the day to seek shelter, but move to more open shrublands and grasslands at night to feed, and thus favor forest habitat interspersed with shrubland/grassland habitats. Bears favor large stands of contiguous forest, but also use shrublands with abundant berries and other forage.

Several special habitat features have been identified in forests that are important to wildlife. Snags, which are dead or dying trees, are critical to many species of wildlife. Cavities in snags provide shelter and nesting sites for woodpeckers, owls, and other cavity-using wildlife, while dead and dying bark often harbors large numbers of insect prey for birds. Edges are places where different plant communities or successional stages meet, such as between a forest clearing and dense forest stand. A large number of species are found at edges, and some species reach their maximum population densities there (Hunter 1990). For some species of birds, however, nest predation is higher for individuals nesting near edges than for those nesting in the forest interior.

A number of species rely on old-growth forests for most or all of their life requisites. Old-growth forests in the Marine Ecoregion generally consist of conifer trees with a diameter of more than 3 feet at the base of the tree, and that are more than 200 years old (Bolen 1998). These forests also contain a multilayered canopy and numerous snags and logs. Vaux's swifts depend on large, hollow snags for nesting and roosting habitat. Marbled murrelets use the stout branches of old-growth trees for nest platforms. Northern spotted

owl nest in tree cavities and feed on northern flying squirrels. Banana slugs, Pacific giant salamander, Olympic salamander, and Oregon slender salamander are other species that prefer the rotting logs and moist soil conditions found in old-growth habitats.

Special Status Species

There are over 75 terrestrial animal species occurring on or near public lands in the treatment area that are federally listed as threatened or endangered, or proposed for listing. Included in the total number are 10 species of arthropod, 7 species of amphibian, 5 species of reptile, 20 species of bird, and 27 species of mammal. A complete list of special status animal species may be found in Appendix J. Please note that this list is dynamic, and will likely change throughout the time period considered by this PER.

Special status animal species are found on public lands throughout the U.S. Special status arthropods are largely butterflies that occur mostly in open habitats. Special status amphibians occur in wetland habitats throughout the West, and special status reptiles occur in warm habitats of California and the southwest. Special status birds and mammals use a wide range of habitats found on public lands throughout the western U.S.

Livestock

Approximately 161 million acres of public lands are open to livestock grazing, with use levels established by the Secretary of the Interior and administered through the issuance of grazing permits/leases. The majority of the grazing permits issued by the BLM involve grazing by cattle, with fewer and smaller grazing permits for other kinds of livestock (primarily sheep and horses).

The BLM administers grazing lands under 43 CFR Part 4100 and BLM Handbooks 4100 to 4180, and conducts grazing management practices through BLM Manual Handbook H-4120-1 (*Grazing Management*; USDI BLM 1984a). Management of livestock grazing is authorized and enforced through both permits and leases, and is commonly carried out through the development and implementation of allotment management plans (AMPs) and/or terms and conditions of the grazing permit or lease. The grazing permit establishes the allotment(s) to be used, the total amount of use, the number and kind of livestock, and the season of use. The grazing permit may also contain terms and conditions as appropriate to achieve management and resource condition objectives. Allotment management plans further outline how livestock grazing is managed to meet multiple-use, sustained-yield, and other needs and objectives, as determined through land use plans.

Geographically specific rangeland health standards and guidelines are identified for each state to help direct the grazing program for those states. Each year the BLM conducts reviews of land within its jurisdiction to determine the level of compliance with rangeland health standards. At a minimum, grazing is managed to ensure that 1) watersheds are in or making significant progress towards properly functioning physical condition; 2) ecological processes including the hydrologic cycle, nutrient cycle, and energy flow are maintained; 3) water quality complies with state water quality standards; and 4) significant progress is being made toward restoring or maintaining habitats for all special status species, including federally-listed threatened or endangered species. Reviews of rangeland health standards are often conducted when grazing permits or leases expire, particularly when those permits or leases are within high priority watersheds.

Public lands provide an important source of forage for many ranches and help to support the agricultural component of many communities scattered throughout the west. As of October 2005, the total number of grazing permits/leases in force was 17,940, with a total of 12.7 million Animal Use Months (AUMs) authorized (Table 3-6; USDI BLM 2006d). Grazing authorizations produced approximately $14.5 million in annual revenues in FY 2005 (USDI BLM 2006c).

Wild Horses and Burros

The BLM, in conjunction with the Forest Service, manages wild horses and burros on BLM- and Forest Service-administered lands through the *Wild Free-Roaming Horse and Burro Act of 1971*. In FY 2005, wild horse and burro populations on public lands totaled over 31,760 animals, with nearly half of these animals living in Nevada (Table 3-7). Another 25,000 animals are held in holding pens. The population of wild horses and burros is approximately 4,000 animals above the Appropriate Management Level (AML) of 27,500. The AML is an estimate of the number of wild horses and burros that public lands can support while maintaining a thriving natural ecological balance (USDI BLM 2006c, d).

TABLE 3-6
Grazing Permits and Leases in Force and Active Animal Unit Months during Fiscal Year 2005

State	Leases and Permits	Active AUMs
Arizona	757	660,511
California	573	421,843
Colorado	1,588	662,920
Idaho	1,889	1,351,806
Montana, North Dakota, and South Dakota	4,289	1,366,331
Nevada	644	2,130,112
New Mexico, Oklahoma, and Texas	2,290	1,861,369
Oregon and Washington	1,579	1,058,756
Utah	1,525	1,237,117
Wyoming and Nebraska	2,806	1,950,312
Total	17,940	12,701,077
Source: BLM Public Land Statistics (USDI BLM 2006d).		

Animals are managed within 201 Wild Horse and Burro Herd Management Areas (HMAs; USDI BLM 2006c). Wild horse herds grow at an average rate of 20% annually. Management is accomplished by carefully controlling horse and burro populations so that their numbers do not exceed the carrying capacity of the land. This is done primarily by gathering animals periodically so that numbers are near the AML. Fertility control is being used in some HMAs as a means to reduce the population growth rate. It has shown to be effective thus far and will likely be used on a larger scale in future years.

When horse and burro populations begin to exceed the AML, excess animals are gathered and offered to the public through periodic adoption. In FY 2005, 5,700 wild horses and burros were adopted in the U.S. Thirty-two percent of these were adopted in the eastern U.S. Nearly 209,000 animals have been adopted since 1971 (USDI BLM 2006d). In 2001, the BLM implemented a program to further reduce the wild horse and burro population to approximately 27,500 animals. Public lands inhabited by wild horses or burros are closed to grazing under permit or lease by domestic horses and burros. *The Wild Free-Roaming Horse and Burro Act* mandates that wild horses and burros can only be managed in areas where they were found in 1971. Those that stray onto non-designated public and/or private lands are removed.

Paleontological and Cultural Resources

Paleontological Resources

The BLM is responsible for managing the public lands and their various resources so that they are utilized in a manner that will best meet the present and future needs of this Nation. The western U.S. has a fossil record that includes almost all of the geologic periods from the Cambrian (500+ million years ago) to the Holocene (Recent; the last 10,000 years), and nearly every imaginable ancient environment. Many fossil deposits are of national and international importance, and many thousands of different kinds of fossils were originally made known to the scientific world from specimens first found in the west.

The BLM manages fossils as a natural heritage resource on the lands it administers under the general guidance of the FLPMA and NEPA. Fossils are managed to promote their use in research, education, and recreation, and paleontological localities are an important consideration in developing land use management decisions. More than 200 properties, totaling more than 5 million acres, are managed either wholly or in part for paleontological values or contain paleontological values that may require special management strategies in the future. Significant paleontological resources can also be found on other public lands estimated to total over 20 million acres. Because of the increasing interest and activity related to fossils over the past 3 decades, it is estimated that there are more than 50,000 fossil sites documented on public lands. Table 3-8 lists the localities that include many of these sites.

Cultural Resources

Cultural resources include archaeological, historic, or architectural sites, structures, or places with important public or scientific uses, and may include definite locations (sites or places) of traditional cultural or religious importance to specific social or cultural groups. Cultural resources are concrete, material places and things that the BLM locates, classifies, and ranks. The BLM manages cultural resources according to their relative importance, to protect significant cultural resources from inadvertent loss, destruction, or impairment, and to encourage and accommodate.

TABLE 3-7
Wild Horses and Burros on Public Lands in Fiscal Year 2005

State	Wild Horses			Wild Burros		
	Free-Roaming Population	Adopted	Removed	Free-Roaming Population	Adopted	Removed
Arizona	230	218	1	1,542	91	53
California	3,079	705	992	1,228	231	252
Colorado	800	292	357	0	17	0
Idaho	704	110	360	0	0	0
Montana, North Dakota, and South Dakota	142	4	0	0	0	0
Nevada	13,251	54	5,805	1,464	0	68
New Mexico, Oklahoma, and Texas	82	916	23	0	69	0
Oregon and Washington	2,670	313	891	15	6	0
Utah	2,420	173	248	142	20	0
Wyoming and Nebraska	3,991	420	1,973	0	1	0
Total	27,369	3,205	10,650	4,391	435	373

Source: BLM Public Land Statistics (USDI BLM 2006c).

the appropriate uses of these resources through planning and public participation

The cultural heritage for public lands administered by the BLM in 17 western states extends back 11,000 to 13,000 years before the present (BP). As one moves forward in time, the number and variety of sites increases mainly as a result of the increase in Native populations and, after 1500 AD or so, European and Euroamerican immigration.

Table 3-9 summarizes the number of acres of public lands inventoried for cultural resources, the number of properties found on public lands, and the number of properties listed in the NRHP.

American Indian and Alaska Native Cultural Resources

This review uses the culture area approach as defined in the *Handbook of North American Indians* (Sturtevant 1978-2001). See Map 3-11 for the location of these areas. These regions represent areas within which specific cultural groups shared certain cultural characteristics and histories. Each culture area section provides a brief review of the archaeology and ethnography of that area. Table 3-10, summarizing examples of major types of archaeological sites likely to be in each culture area, follows this section.

Arctic and Subarctic (Alaska)

Archaeological research suggests that the earliest human migrants crossed into the New World via the Bering Land Bridge, likely following large herbivorous Pleistocene animals, such as mastodon, woolly mammoth, horse, and American bison. In this culture area, typical artifacts from the period 13,000 to 9,000 Before Present (BP) include lanceolate projectile points, bifacial knives and scrapers, and retouched flake tools (Ames and Maschner 1999, Dixon 1999). Cultural resource sites from this time period include open campsites, habitations or campsites located in caves or rockshelters, and sites where game animals were killed and/or processed.

As the post-glacial climate in Alaska warmed, prehistoric cultures became more established. Early aboriginal groups, with a subsistence strategy similar to that of the Paleoindians, used tool assemblages dominated by microblades, small wedge-shaped cores, and burins.

Cultures from 9,000 to 6,000 BP often are referred to as the Microblade Tradition (Dumond 1987). In addition to open campsites and sites with skin-covered tents, semi-subterranean houses are documented for this period (Anderson 1984). By 6,000 BP, the Northern Archaic Tradition had arisen in the boreal forests of the interior,

TABLE 3-8
Interpreted Paleontological Sites on Public Lands

State	Interpreted Locations
Colorado	• Dinosaur Diamond Byway • Gard Park Fossil Area • Kremmling Cretaceous Ammonitie Locality • Rabbit Valley Trail Through Time • Fruita Paleontology Area
Idaho	• Malm Gulch Area of Critical Environmental Concern (ACEC)
Utah	• Cleveland Lloyd Dinosaur Quarry • Copper Ridge Sauropod Dinosaur Tracks • Mill Canyon Dinosaur Trail • Warner Valley Dinosaur Track Site
Wyoming	• Red Gulch Track Site ACEC • Big Cedar Ridge Fossil Plant Area ACEC • Dry Creek Petrified Tree Environmental Education Area

represented by small, seasonal campsites and tool assemblages composed of lanceolate and side-notched projectile points and scrapers (Dumond 1987). Technological advances during the period 6,000 to 250 BP led to the development of several distinct cultures. Tool kits of the widespread Arctic Small Tool Tradition included small stone endblades and sideblades inserted into the shafts of arrows or spears (Dumond 1987). Populations of Arctic Small Tool Tradition people developed highly specialized maritime technologies (kayaks, umiaks, dogsleds, toggling harpoons, bow and arrows, and ground slate tools). Habitations, in the form of semisubterranean houses, often were clustered in villages (McCartney 1984, Dumond 1987).

At present, the Alaska Natives and Indians are the dominant native groups of Alaska. In general, the Inuit (Eskimo and Aleut) inhabit the coastal areas and adjacent tundra, while Indians (Athabaskan or Tlingit) inhabit the interior forests and southeast Alaska, though both groups have tremendous intra-cultural diversity and overlapping resource exploitation areas. Terrestrial and marine mammals and fish are the primary source of food for both groups; plants being of lesser importance, given the short growing season.

Kelp and berries are the principal plant foods, with mushroom, wild parsnip, wild rhubarb, and lupine roots also gathered. Dune grass is used to weave baskets and mats (Kehoe 1992). Alaskan Indians have focused their subsistence activities on marine whales and seals, seasonal fish runs, and inland caribou herds and a variety of other land mammals.

Edible plant resources of the interior include a wide variety of berries, fern roots, lily bulbs, mushrooms, wild onions, wild rhubarb, rose hips, and various roots (Kehoe 1992). Birch bark continues to be used for the manufacture of many utilitarian objects, including baskets, shelters, cooking pots, and canoes. The wood of birch, spruce, and willow has been used for bows, arrows, snowshoe frames, wooden tools, and house and canoe frames. Ropes and fishing nets have been made from willow bast, nettle fibers, and spruce roots. Additional uses of spruce roots include containers, basketry, sewing thread, and twine (McClellan and Deniston 1981).

Northwest Coast

Archaeological evidence for occupation of this culture area dates back to about 11,000 BP, though faunal remains from the Olympic Peninsula suggest human presence earlier than 12,000 BP (Lyman 1991). Early peoples' subsistence systems focused on maritime resources, and typical artifacts consist of large chipped stone projectile points, microblades, compound harpoons, and grinding stones (Ames and Maschner 1999). Due to the damp climate and acidic soils in this region, faunal remains and tools made from perishable items dating to this period are rarely preserved. In addition, the changing sea levels over the last 10,000 years have inundated many of the older occupation or processing sites.

TABLE 3-9
Cultural Resources on Public Lands

State	Number of Acres (in millions)	Number of Acres Surveyed	Percent of Acres Surveyed	Number of Properties Recorded
Alaska	85.5	109,872	0.1	3,205
Arizona	12.2	822,100	6.7	11,858
California	15.2	1,813,118	11.9	28,454
Colorado	8.4	1,493,770	17.9	39,232
Idaho	12.0	2,020,017	16.8	14,604
Montana, North Dakota, and South Dakota	8.3	1,340,862	16.2	10,224
Nevada	47.8	2,183,973	4.6	44,851
New Mexico, Oklahoma, and Texas	13.4	1,441,183	10.8	34,931
Oregon and Washington	16.5	1,585,580	9.6	12,623
Utah	22.9	1,801,321	7.9	38,526
Wyoming and Nebraska	18.4	2,590,769	14.1	40,157
Total	260.6	17,202,565	6.6	278,665
Source: BLM Public Land Statistics (USDI BLM 2006f).				

By about 5,000 BP, sea levels rose and stabilized, and distinctive cultural patterns emerged. Bone and ground stone tools were prevalent from Southeast Alaska to Puget Sound, as were large settlements and specialized maritime subsistence strategies. There is evidence of sedentism (pithouses and shell middens in western Washington) from 3,500 BP, and it appears that by 3,000 BP, trade networks with Plateau cultures were well established (Nelson 1990). Petroglyph sites begin during this period (Boreson 1998, Ames and Maschner 1999).

By 1,000 BP, most Northwest Coast groups occupied village sites on a year-round basis. Many village sites were located for defensive purposes and included fortifications, suggesting the presence of warfare, social complexity, and competition for resources (Ames and Maschner 1999). Typical artifacts include composite woodworking tools, netsinkers, bone and antler tools, and copper and iron tools. Archaeological sites in the Northwest Coast region are generally difficult to locate because of dense vegetation and poor preservation (Nelson 1990).

A handful of "wet sites" occurring in the Pacific Northwest have been systematically studied, with excellent preservation of organic components, such as acorns, wood, and basketry items, from prehistoric sites on the Olympic Peninsula of Washington, including Ozette, the Hoko River, and Mud Bay, and also the "Sunken Village" on the Willamette River in Oregon (Croes 2007).

Food resources currently used by native Northwest groups include salmon, halibut, cod, candlefish (an important source of dietary oil), clams, whales, elk, deer, mountain sheep, and bear. Plant food sources, which are numerous in this culture area, include edible ferns and lilies, the tuber of the wapato, over 40 fruits and berries, edible nuts, leaves, and shoots, and certain types of algae, seaweed and kelp. Many groups used controlled burning to maintain prairies, and berry, root, and nut-producing areas along the coast from California to British Columbia (Suttles 1990, Ames and Maschner 1999).

Forest resources are used extensively, particularly western red cedar and Alaska cedar, for canoes, for plank house construction, and for specialized ritual purposes such as totem poles and masks. Sitka spruce has often been used for houses and canoes, and western hemlock and Douglas-fir saplings have been used to construct fish weirs. Red alder, Rocky Mountain maple, and Alaska cedar have been used for spoons, bowls, masks, and dishes; and western yew has been used for bows, wedges, clubs, and digging sticks. Plant materials used to make rope and cordage include the limbs of western red cedar, the stipes of bull kelp, the roots of cedar and spruce, and the fibers of stinging nettle and Indianhemp. Materials used in basketry include cedar

TABLE 3-10
Culture Areas, Prehistoric Occupation Periods, and Selected Common Site Types

Culture Area	Paleoindian	Middle Period or Archaic	Late or Sedentary Period
Arctic and Subarctic	*13,000+ to 9,000 B.P.* Open campsites Cave or rockshelter occupation sites Animal kill and lithic processing sites	*9,000 to 6,000 B.P.* Semi-subterranean houses Open campsites and tent camps	*6,000 to 250 B.P.* Semi-subterranean house villages Open campsites and tent camps
Northwest Coast	*12,500+ to 6,000 B.P.* Open campsites Cave or rockshelter occupation sites		*6,000 to 250 B.P.* Large, cedar plank pithouse villages Fortified sites Seafood capture or processing sites Pictograph and petroglyph sites
California	*11,000(?) to 8,000 B.P.* Open campsites Animal kill or processing sites	*8,000 to 5,000 B.P.* Open campsites and coastal villages Plant or seafood processing sites	*5,000 to 250 B.P.* Large coastal villages Burial mounds Extensive seafood, sea mammal, and plant processing sites Pictograph and petroglyph sites
Great Basin	*11,500+ to 8,000 B.P.* Open campsites Cave occupation sites Lithic processing sites	*8,000 to 4,000 B.P.* Cave or rockshelter occupation sites Pithouse villages Plant and lithic processing sites Fishing sites	*4,000 to 250 B.P.* Cave or rockshelter occupation sites Small pithouse villages Plant and lithic processing sites Storage pits Pictograph and petroglyph sites
Southwest	*11,500 to 8,000 B.P.* Open campsites Animal kill and lithic processing sites Cave occupation sites	*8,000 to 2,000 B.P.* Open campsites Cave or rockshelter occupation sites Pithouses and storage pits Waddle and daub structures Lithic processing sites Pictograph and petroglyph sites	*2,000 to 250 B.P.* Pithouse villages Storage pits Above-ground structures (Pueblos) Below-ground structures (Kivas) Irrigation ditches and roads Navajo hogans and pueblitos Pictograph and petroglyph sites
Plains	*12,000 to 8,000 B.P.* Open campsites Cave or rockshelter occupation sites Animal kill and lithic processing sites	*8,000 to 2,000 B.P.* Open campsites Cave or rockshelter occupation sites Pithouses and storage pits Tipi ring sites Cairns and cairn lines Animal kill, lithic, and plant processing sites	*2,000 to 250 B.P.* Open campsites and tipi ring sites Waddle and daub structures Earthlodge villages Burial mounds Storage pits Cave or rockshelter occupation sites Small pithouse villages Cairns and cairn lines Animal kill, lithic, and plant processing sites Pictograph and petroglyph sites
Plateau	*12,500 to 8,000 B.P.* Open campsites Cave or rockshelter occupation sites Fishing sites Lithic processing sites	*8,000 to 4,000 B.P.* Open campsites Small pithouse villages Cave occupation sites Animal or fish processing sites Lithic processing sites Plant processing sites	*4,000 to 250 B.P.* Pithouse and longhouse villages, often with burials Open campsites Cave occupation sites Storage pits Animal or fish processing sites Lithic and plant processing sites Pictograph and petroglyph sites

roots, cattail, tule, beargrass, and various sedges and grasses. The inner bark of western red cedar and Alaska cedar is used for baskets, mats, skirts, capes, towels, and diapers. There are numerous medicinal plants in the Northwest region, including devil's club, kinnikinnick, hogfennel, and tobacco (Suttles 1990).

Southwest

Between 11,500 and 8,000 BP, human groups practiced a highly mobile hunting and gathering subsistence strategy. In general, the oldest archaeological sites in this culture area are located near now extinct springs, large and small Pleistocene lakes (playas), or major drainages, and consist of open camps, animal kill sites, animal processing sites, or caves.

Archaeological sites dating from 8,000 to 2,000 BP are either open campsites located near water sources, containing chipped and ground stone tools, or are in rockshelters or caves, where well-preserved twined sandals, wood artifacts, and basketry are often recovered (Kehoe 1992). Horticulture was introduced into the southwest as early as 4,500 BP, although domestic crops did not substantially contribute to the diet until later (Woodbury and Zubrow 1979). Typical artifacts of the period include stemmed projectile points used with atlatls, basketry, scrapers, grinding slabs, and cobble tools. Remains of surface structures, made of posts and brush or other material, are documented beginning midway through the period in the West (Irwin-Williams 1979). The first pit house sites and storage pits are documented late in this period (Woodbury and Zubrow 1979). Petroglyphs and pictographs are first produced during this time period (Schaafsma 1980).

Researchers have subdivided the Southwest, starting from about 2,000 BP, into the Anasazi, Mogollon, Hohokam, and Hakataya geographical-cultural areas. The Anasazi occupied variable topography during the generally cooler and moister climates; the Mogollon inhabited well-watered, forested and mountainous regions; the Hohokam were located in low, dry deserts; and the Hakataya occupied the hot desert regions bordering the lower Colorado River (Woodbury 1979). Parts of the region were intensively occupied and socially and economically linked to the civilizations of the Mexican Classic Period, when sedentary cultures began to emerge (Irwin-Williams 1979).

Maize was cultivated in earnest by about 2,200 BP, and was soon followed by beans, squash, cotton, and other crops (Irwin-Williams 1979; Woodbury and Zubrow 1979). By 1,700 BP, some inhabitants of the region had developed sophisticated irrigation, pottery, storage pits, and pit house villages. Eventually, small to large permanent towns of multi-story, aboveground structures (pueblos) were developed. Sites dating to this period may include features such as irrigation canals, wells, storage pits, and roads. Typical artifacts consist of pottery (used for the storage of crops), basketry, and small corner-notched projectile points indicating the adoption of the bow and arrow by 1,500 BP (Woodbury and Zubrow 1979).

The Pueblo Indians are best known for their agricultural development of corn, beans, and squash. In addition, wild plants (e.g., amaranth, chenopods, wild onion, wild celery, sage, grass seeds, juniper berries, pine nuts, acorns, walnuts, agave, prickly pear, and tree cholla) were eaten (Bodine 1979, Plog 1979). Other plants are used for clothing, shelter, and medicine. Baskets are made from yucca fibers, cotton is used for weaving, blankets are made from small palms, yucca roots are used for hair washing, and gourds are used as containers (Bodine 1979, Kennard 1979, Plog 1979, Schroeder 1979).

The Yuman groups (Colorado River Tribes) living along the Colorado and Middle Gila rivers have traditionally cultivated corn, squash, pumpkins, melons, beans, and cotton (Maxwell 1978). Important animal foods include small game and fish, and important plant resources include prickly pear, saguaro, mesquite, and numerous nuts and berries (Maxwell 1978, Jorgensen 1980). Yuman groups living on or near the Colorado Plateau practiced agriculture in the canyons in summer, then hunted deer, antelope, bighorn sheep, and rabbits in the fall. They also gathered pinyon nuts, juniper berries, various cacti, and other plants for both subsistence and domestic purposes (Khera and Mariella 1983, McGuire 1983, Schwartz 1983).

Southern Athapaskan or Apachean-speaking tribes occupied much of eastern Arizona, portions of New Mexico around the Pueblos, southeastern Colorado, western Oklahoma, and parts of western and southern Texas beginning about 700 BP. Following contact with the indigenous Pueblo peoples, the Navajo readily adopted maize, bean, and squash agriculture. The Western Apache, Jicarilla, and Lipan cultivated crops less intensively, and the remaining groups did not adopt any agricultural practices. With arrival of the Spanish, the Navajo readily adopted the raising of horses, sheep, goats, and cattle, and cultivated orchards and other introduced crops (Basso 1983, Opler 1983, Tiller 1983, Witherspoon 1983).

Traditional plants gathered by the Apacheans include agave crowns, saguaro cactus fruit, yucca, prickly pear, mesquite beans, acorns, pinyon nuts, numerous berries, grass seeds, wild root crops, and various greens or young plants. Yucca has been used to make shampoo, and the sap of Spanish bayonet and other plants has been used to make dyes. Common basketry plants include sourberry, willow, martinia, and bata mota. At least 29 species of plants have been used for medicinal purposes. Various large and small game animals were hunted for food and hides.

Great Basin

Two of the oldest archaeological sites in this culture area are the Tule Springs campsite (11,000 BP) and Danger Cave (9,000 BP; Aikens 1983). Typical artifacts of the period from 11,000 to 8,000 BP include lanceolate-shaped and long-stemmed projectile points, occasional fluted points, specialized scrapers, chipped stone crescents, and drills (Warren and Crabtree 1986). This period also includes the earliest evidence of basket making (Adovasio 1986). Inhabitants of the region likely were highly mobile hunter-gatherers with a generalized big game hunting and collecting economy.

The warm and dry climatic conditions during 8,000 to 7,000 BP limited human subsistence activities. Sites dating to this period are rare, and include caves (Aikens 1983) and rockshelters in drier areas, or pithouse villages located in valley bottoms near permanent streams and springs (Elston 1986). During this period, generalized hunting and collecting remained the major subsistence practices, although seed collecting and processing activities gained importance, as indicated by bedrock mortars and milling stones. Root collecting and fishing also gained importance during this period (Mehringer 1986). Typical artifacts include projectile points used with atlatls, basketry, twined sandals, and various wooden implements (Aikens and Madsen 1986).

By about 4,000 BP, subsistence systems were broad-based and resource-rich areas were heavily exploited seasonally. The shift in styles of projectile points over time indicates the adoption of the bow and arrow. While caves continued to be occupied (Aikens 1983), many locations along major rivers contained small pithouse villages with associated storage facilities (Butler 1986). Horticulture was introduced in the eastern Great Basin and Owens Valley by Southwest cultures around 1,500 BP. Outside of these areas, hunting and gathering remained the primary form of subsistence. An expanded reliance on pinyon nut gathering, as evidenced by mortars and pestles, also occurred during this period (Aikens and Madsen 1986, Elston 1986). Petroglyphs were common by 3,000 BP and pictographs by 1,000 BP (Schaafsma 1986).

Prior to the acquisition of the horse in the late 1700s, Shoshone and Northern Paiute in the High Desert region and western Wyoming fished for salmon in the spring and dug camas roots in the summer. These groups traveled to the mountains of southeastern Idaho and northern Utah to hunt deer and elk in the fall. After the development of equestrian culture, ranges and territories extended into present-day Wyoming and Montana, in seasonal pursuit of buffalo.

In the high desert, the single-leaf pinyon nut was an important staple, along with plant resources such as chenopod, blazingstar, grass seeds, mesquite, salvia, various cacti, and gourds (Egan 1917; Steward 1939, 1997; Thomas et al. 1986). The Western Shoshone wore hats made from twined sage bark or willow and clothing made from bark, grass, or fur. A large number of plants have also been used for basketry in this region (Adovasio 1986; Fowler 1986; Thomas et al. 1986). The Eastern Shoshone pursued game more extensively, while fish were a substantial part of the Northern Paiute diet (Liljeblad and Fowler 1986, Murphy and Murphy 1986, Shimkin 1986).

The aboriginal groups of the low desert, such as the Ute, Southern Paiute, Kawaiisu, Owens Valley Paiute, and Panamint, exhibited seasonal migration by traveling into the deserts and valleys in the winter and mountains in the summer. With the introduction of horses, these groups ranged onto the Plains, and adopted a Plains pattern, such as buffalo hunting and use of long-pole tepees (Conetah 1982, Janestki 1991, Kehoe 1992).

Plants utilized within the low desert region included berries, roots of sego lily and bulrush, some cacti, pinyon, and mesquite beans. Low desert tribes also hunted large and small animals (Kelly 1964, 1976; Kroeber 1976; Kelly and Fowler 1986). Plant materials used to make cordage included sagebrush bark, juniper bark, dogbane, yucca, and nettle. Tule reeds had multiple uses, in such items as balsa rafts, mats, and blankets (Callaway et al. 1986). Present day Moapa Paiutes still use desert fan palms for making baskets, food, and shelter (Moapa Memories 2002). Jimson weed, tobacco, nettle, and red ants are some of the traditional medicines used by Native groups in this region (Zigmond 1986).

Plateau

Because of the arid climate during the period from 12,500 to 8,000 BP, resources in this culture area were concentrated along the margins of rivers and major tributaries. Archaeological sites dating to this period include caves, rock shelters, and open camps. The low frequency of early sites is generally attributed to the low population densities of the highly mobile hunter-gatherers who occupied the Plateau. Stemmed and unstemmed lanceolate projectile points, microblades, cobble tools, scrapers, gravers, and bifaces are common artifacts associated with the period. Although groups engaged in fishing, intensive utilization of riverine resources did not occur until later, when climatic conditions stabilized (Ames et al. 1998; Ames and Maschner 1999).

A gradual increase in moisture from 8,000 to 4,000 BP helped expand the range of sagebrush steppe and stimulate the productivity of root crops across the region. Human groups continued to practice highly mobile subsistence strategies with an increasing reliance on salmon (Chatters and Pokotylo 1998). Other than the addition of large side-notched points, and a decrease in the overall size of projectile points, evidence of atlatl use, the tool kit is similar to that of the preceding period. The appearance of individual or small numbers of pit houses along major drainages signified the rise of semi-sedentary settlement strategies, and hopper mortars and milling stones provide evidence for the increased importance of roots and other plant resources in the diet. Other site types include large open sites lacking evidence of habitations, caves, short-term camps, resource extraction sites, and resource processing sites, generally located farther from the major drainages (Ames et al. 1998).

A cooling climate around 4,000 BP helped to stabilize salmon productivity by restricting the seasonality of the salmon migrations (Butler and Schalk 1986). In response, inhabitants of the Plateau intensified their use of salmon, storing it for year-round consumption, and structuring their subsistence strategies to coincide with seasonal salmon migrations. Semi-permanent villages of various-sized pit houses, and longhouses appearing about 1,500 BP, were located mainly along rivers and major tributaries and occupied during the winter months. Some of the habitations were eventually used for human burials. Camps positioned at strategic resource locales in the uplands and mountains were used on a seasonal basis. Cave sites produce well-preserved wood and fiber artifacts. The adoption of the bow and arrow; specialized fishing technologies including nets, harpoons, and barbed bone points; and the continued presence of grinding and pounding tools are evidence of increasingly complicated subsistence strategies (Ames et al. 1998). Petroglyphs and pictographs, dating as early as 3,500 BP, are most common near the larger settlements on major rivers (Boreson 1998).

The hallmark of northern and southern Plateau cultures is still salmon fishing. For many Plateau groups, plant resources also constitute a large portion of the diet. Significant plant resources utilized by these groups include root crops of camas, bitter root, lomatium, balsamroot, and yellowbells, and various berries. These plant resources have not only provided food, but have also been used for such functions as shelter, clothing, basketry, and medicine. Some Plateau groups traditionally burned habitats to enhance the production of usable plant material, including berries (Chatters 1998, Ross 1998).

In the southern Plateau, traditional dwellings were semi-subterranean and constructed from wood and large mats made of tule bulrushes or cattail reeds, sewn together with Indianhemp (Schuster 1998). The main firewoods of the region are Douglas-fir and ponderosa pine, with alder wood preferred for cooking or smoking salmon. Douglas-fir saplings have been used for fish net poles, greasewood twigs for sewing needles, Indianhemp for fishing nets and other weaving purposes, and cattail leaves for weaving bags. Rosewood has been used in cradleboards, and has been hung in homes to repel ghosts. Medicinal and religious plants include mullein, willow bark, and tobacco (Hunn 1990, Hunn and French 1998).

In the northern Plateau, tule reeds and cedar bark were used for covering structures, and tule was also used for matting and bedding, and to shroud corpses. Sources of baskets and bags included birch bark, cedar bark, cedar and spruce roots, and Indianhemp (for cordage). Underground storage casks were made from cottonwood bark, canoes were made from white pine bark, snowshoe frames were made from maple boughs, and mats used to dry salmon were made from willow shoots. Sources of dye included huckleberries and the inner bark of Oregon grape, and sunflower root was used to make shampoo (Kennedy and Bouchard 1998, Miller 1998).

California

The Lake Mojave sites, dating to over 10,000 BP, represent some of the oldest archaeological materials in

this culture area. These sites include evidence of big game hunting and gradual expansion into the use of plant resources. Open camp and processing sites suggest that there were few early occupants of the region who maintained a highly mobile subsistence strategy. Artifacts include large, fluted projectile points, lanceolate-shaped points, shouldered points, chipped stone crescents, scrapers, knives, and choppers (Wallace 1978).

Between 8,000 and 7,000 BP, an arid environment caused lakes and marshes to dry, forcing people to adapt to new environments (Moratto 1984). Based on the presence of milling stones, a shift from big game hunting to plant and seed collecting occurred between 8,000 and 5,000 BP. Artifact assemblages are surprisingly homogeneous, consisting mostly of heavy, deep-basined milling and hand stones, with occasional projectile points that were likely used with atlatls (Wallace 1978).

About 5,000 BP, transition began toward a more diversified subsistence economy that included the exploitation of marine and terrestrial resources. Inland sites show evidence of intensive plant processing indicated by the presence of mortars and pestles. Archaeological and climatic evidence from the last 2,000 years indicates that subsistence and settlement patterns in California remained quite stable. Coastal groups relied on marine resources; northern groups relied on riverine resources, especially salmon; central and southern groups relied on lake and marsh resources; and groups throughout the state relied on deer and acorns. The presence of bedrock mortars in the Sierra Nevada foothills indicates continuous use of the same areas. There is also evidence that widespread burning of forests was conducted to stimulate plant growth and provide forage for deer, a universal food source (Driver and Massey 1957, Lewis 1973, Bendix 2002). The earliest petroglyphs appear to correlate with similar ones from the Great Basin dating 3,000 BP, while very elaborate, perhaps ceremonial, pictographs are thought to be no more than 1,000 years old (Clelow 1978).

Coastal groups have long exploited coastal marine and inland oak forest resources, where they collect acorns and hunt large and small game. A variety of plants provide building materials, basketry materials, clothing, and medicine. The redwood tree was used to construct permanent dwellings and large canoes, as well as clothing made from its bark. Juniper and tule were also used to make shelters. Tule reeds are used in basketry (in addition to numerous other plants), boats, clothing, and matting. Materials used to make dyes include green oak galls, burned pepperwood berries, tan oak bark, and alder bark. Medicinal plants include tobacco, angelica, and pepperwood leaf (Loeb 1926, Maxwell 1978).

In the valleys between the Sierra Nevada and coastal ranges, riparian corridors and foothills rich in oak groves provide acorns, a staple diet of many California tribes. Migrating salmon are an important food source, as are berries, bulbs, tubers, and roots. Native groups of the Central Valley and Sierra region hunted waterfowl using snares, nets, arrows, and decoys. Tule growing in wetlands has been an important component of baskets, matting, dwellings, and watercraft. Plants used for cordage and rope include milkweed, Indianhemp, dogbane, and inner willow bark. Medicinal plants include tobacco and horehound (Levy 1978, Wallace 1978).

In the desert region of southeast California, important tribal resources included fish, shellfish, deer, rabbit, rodents, and insects. Additional dietary staples, still used, include wild grass, mescal beans, pinyon seeds and nuts, and mesquite beans, which are ground into flour and made into cakes (Barrows 1900, Kelly 1964, Kroeber 1976).

In the desert region, dwellings were constructed from a wide variety of plants, including juniper, manzanita, greasewood, mountain oak, and mesquite, with tule, carrizo, ferns, bark, or reeds often used for thatching. Plants used for basketry include tule, sumac, squawbrush, and a variety of rushes and grasses. Yucca has been used for cordage. A number of plants were used for clothing and sandals, including the inner bark of willow and cottonwood trees, mescal and yucca fibers, and mesquite bark. Creosote bush and milkweed were used as adhesives, and yucca root has been used to make soap. Among the wide variety of medicinal plants are tobacco, jimson weed, wormwood, creosote, and sumac (Bean and Saubel 1972).

Plains

Human occupation of this culture area dates to at least 11,500 BP. Highly mobile hunters occupied sites on a short-term basis or repeatedly over varying lengths of time. These sites, which were frequently located near water sources, often include finely manufactured fluted, stemmed, or lanceolate points in association with skeletons of extinct game species.

American bison hunting has played a significant role in the subsistence economy of Plains groups throughout prehistory. Additional utilized fauna included elk,

mountain sheep, deer, antelope, bear, and various small mammals, as well as fish, freshwater mussels, reptiles, and amphibians. Archaeological evidence indicates that roots, bulbs, berries, fruits, and seeds were collected and often processed using a variety of grinding stones (Frison 2001, Vehik 2001).

Typical artifacts of the period from 8,000 to 2,000 BP include medium-sized lanceolate to large, side-notched projectile points, corner-notched dart points, hide scrapers, milling or grinding stones, coiled basketry, and pottery. Although open campsites (often with fire pits), cave or rockshelter sites, and American bison kill and processing sites are the most common sites, burials, as well as sites containing housepits and/or food cache pits are also documented throughout this period. In addition, the use of teepees, based on the presence of stone circles at cultural resources sites, is evident (Frison 2001, Vehik 2001).

Petroglyphs and pictographs (rock art) date from this period (2,000 to 250 BP), occurring on rock outcrops in the northern and northwestern Plains and southeastern Colorado (Frison 2001, Gunnerson 2001). With the appearance of the bow and arrow in the northwestern Plains about 1,900 BP, hunting became more efficient. The use of teepees by the more nomadic western and northwestern Plains dwellers became very common throughout the period, to the point where some multiple stone circle sites are labeled villages (Frison 2001). By 1,500 BP, farming of maize, beans, squash, and sunflowers was established in the eastern Plains and spread to sedentary groups living in earth lodge villages along the Missouri River (Maxwell 1978; Kehoe 1992; Wedel 1961, 1983; Wedel and Frison 2001; Wood and Irwin 2001).

At the time of European contact, plants used for subsistence by Plains groups included prairie turnip, groundnut, ground bean, sunflower, Jerusalem artichoke, serviceberries, mesquite beans, cacti, camas, and grass seeds. Maize, beans, and squash were also cultivated (Maxwell 1978, Wedel 1983, Wedel and Frison 2001). Following the introduction of horses by the Spanish in the 16th century, subsistence patterns of many Plains groups shifted from sedentary, part-time farming and hunting to mounted hunting heavily focused on the migratory herds of American bison. During the 1700s, pressure from the Europeans generated movements of woodland groups, such as the Sioux, onto the Plains. By the late 1700s, the dependence on plants for subsistence by these groups waned (Maxwell 1978).

Plains groups have used plants for a variety of purposes, in addition to subsistence. Tobacco has been used in religious ceremonies. Cottonwood and willow were used to provide fuel and building materials, and willow has been used for boat frames. Oak, elm, and huckleberry are also high quality building materials, and poles made from pine have been used for teepee frames. Willow, box elder bark, and nettles have been used to make baskets, which are often colored with a black dye derived from walnuts. Medicinal plants of the Plains include mescal beans and sweetgrass. Bowls were made from box elder, and bows from cedar, ash, and hickory. Sage was used to help whiten hides (Brown and Irwin 2001, Voget 2001, Wedel and Frison 2001, Wood and Irwin 2001).

European Settlement Resources

Euro-American contacts with the western U.S and Alaska generally began with exploration or trading, with missionary activities soon following in some of the areas. The earliest exploration occurred in the Southwest and in California in the 1500s, with settlements by the military, missionaries, and colonists in the 1600s in the Southwest, and in the later 1700s in California. In the late 1700s, Spanish, Russian, British, and American exploration and trade extended up and down the West Coast of North America. By the late 1700s and early 1800s, explorers such as Lewis and Clark and fur traders traversed the interior of what is now the western U.S. Table 3-11 shows the types of European settlement resources typically present in the cultural areas.

The discovery and the promise of precious metals first inspired conquest of Native People through treaty and force, then created the market for the development of agriculture, timber, and fisheries, and finally motivated the construction of a transportation system sufficient to transport people and goods. Although furs and precious metals drew the first adventurers, a more permanent settlement of the West in the late 19th and early 20th centuries was related to agriculture. In most of the arid regions of the West agriculture primarily consisted of ranching. During this time, the Homestead Act and other similar programs transferred most of the irrigable land to private ownership, and the adjacent public land was used for grazing livestock by the ranchers who had either homesteaded or purchased those private lands. Beginning about the turn of the 20th century, the federal government reserved tracts of land in the West for management by agencies such as the Forest Service and National Park Service, and, after its formation in the

middle of the century, by the BLM. These lands remain in the public domain.

The history of the rural western U.S. encompasses several broad themes and periods including exploration, discovery of the region's mineral wealth, conflict, and settlement, and includes the growth of communities dependent upon resource extraction—farming, ranching, logging, fishing, and mining. These communities were in turn linked to local, regional, and national markets through a complex and evolving system of trails, military roads, wagon roads, rail lines, and navigable river corridors, a trend that continues into the modern period. By the mid-20th century, with the region secured and transportation assured, recreation and tourism increasingly comprised the economic base of western communities, and military training use escalated in response to the training needs of the modern military.

Public lands in the West contain cultural resources representing all major periods and events in the broad sweep of western history. The most common rural manifestations of these dominant themes include transportation resources such as ferry sites, railroads, trails, and roads; military sites (training grounds and battlefields); and mining resources related to exploration (prospect pits), extraction (adits, hydraulic cuts, and quarries), and processing (smelters and mills). Other resources include homesteading, ranching and farming resources (human and animal shelter and irrigation development); fishery resources (boats, fish traps, and weirs); and logging resources (stumpage, sawmills, and human and animal shelter). Evidence of community development includes rural schools, stores, churches, and community centers. Recreation and leisure sites include cabins, resorts, and trail systems.

Important Plant Uses and Species Used by American Indians and Alaska Natives

Although universally important, plant use by Native American and Alaska Native groups is extremely varied, both by region and by group. Subsistence use of such plant products as roots and tubers, stalks, leaves, berries, and nuts is essential to native people. Vegetation also provides habitat for important wildlife species.

Most Native American and Alaska Native groups constructed a variety of residential shelters and other buildings such as ceremonial lodges and sweat houses using a combination of materials, usually employing a locally derived hardwood as part of the structural frame. The frames were then covered with other readily available materials, such as planks, mats, brush, and other materials. Wood has been burned to cook food, warm dwellings, and facilitate toolmaking. Trees have been fashioned into various types of watercraft and terrestrial hauling devices. Various woods have been carved or used to produce utilitarian implements like bowls and spoons, and also ceremonial items, such as pipes and totems, and many other items of material culture.

The use of plants for medicinal purposes is widespread, as is the use of tobacco. Plants such as tobacco, sweet grass, cedar, and sage, have seen important religious and other ceremonial uses. The use of grasses and other plant resources for basket, box, and tool making also can be observed in the cultures of numerous Native American and Alaska Native groups. Plant products also have been used to make textiles, cordage, and matting, as well as to tan hides. The use of plant dyes, paints, and soaps is widespread.

Visual Resources

The public lands administered by the BLM contain many outstanding scenic landscapes. Visual resources in these landscapes consist of land, water, vegetation, wildlife, and other natural or man-made features visible on public lands. Vast areas of grassland, shrubland, canyonland and mountain ranges on public lands provide scenic views to recreationists, visitors, adjacent landowners, and those just passing through. Roads, rivers, and trails on public lands pass through a variety of characteristic landscapes where natural attractions can be seen and where cultural modifications exist. Activities occurring on these lands, such as recreation, mining, timber harvesting, grazing, or road development, for example, have the potential to disturb the surface of the landscape and impact scenic values.

Public lands have a variety of visual (scenic) values which warrant different levels of management. The BLM uses a system called VRM (visual resource management; Manual 8400) to systematically identify and evaluate these values to determine the appropriate level of scenery management (USDI BLM 1984b). The VRM process involves 1) identifying scenic values, 2) establishing management objectives for those values through the land use planning process, and 3) then designing and evaluating proposed activities to analyze

TABLE 3-11
European Settlement Resource Types

Site Type	Examples	Culture Region
Transportation		
River navigation	Fords, cable ferries, and shipwrecks	All
Overland navigation (both railroad and non-railroad)	Trails, wagon roads, truck trails (public and private), engineered features (bridges, trestles, ballast, track, and ties), and construction camps	All
Exploration and Overland Migration		
Trails (most often at topographic restrictions, such as canyons)	Trail ruts (rock) and trail ruts (earth)	All
Geological landmarks with cultural and historical value	Rock promontories, springs, passes, and meadows	All
Inscriptions	Petroglyphs (chiseled inscriptions), pictographs, and carvings on trees	All
Missions	Schools, churches, agricultural plots, orchards, and housing	All
Military		
Battlefields (Indian wars)	Not applicable	All except Alaska
Training grounds	World War I, World War II, Korean War, and Cold War eras	Great Basin and Plateau
Transportation routes	Trails and wagon roads	All
Agriculture		
Ranching and farming	Home ranch facilities (including foundations), outlying buildings and structures, cultural landscape elements (including fences, stock ponds and trails, dams, and river fords), irrigation structures, and archaeological sites	All
Commerce/Urban Development		
Urban settlement	Civic, commercial, and domestic	All
Mining		
Resources associated with extraction	Resources associated with prospecting (locating ore) and development (accessing and removing ore), resources associated with placer mining (sluicing), and lode mining (adits, waste rock, and interior tramways)	All
Resources associated with beneficiation and refining	Mills (various types), smelters, tailing piles, tailing ponds, power plants, and refineries	All
Support facilities	Bunkhouses, mess halls, livestock shelters, and trash dumps	All
Transportation systems	Trails, two-track roads, truck trails, rail lines, and construction debris	All
Logging		
Extraction	Stumps, skid lines, and sky-line cables	All
Processing	Lumber mills and power plants	All
Support facilities	Shingle camps, logging camps, and livestock facilities	All
Transportation	Roads, donkey engines, big wheels, rail lines, and flumes	All
Fisheries		
Extraction (except processing-related and support facilities)	Weirs, fish traps, natural features (falls, eddies), and boats	All
BLM Administration and Development		
Administrative facilities	Buildings (administrative, maintenance, and warehouse) and livestock facilities	All
Interpretation	Museums and interpretive signs	All
Recreation (pre-1934)	Camp sites, developed natural features, summer homes, interpretive signs, roads, and trails	All
Recreation (post-1934)	Campground, developed water source, and roads and trails	All

effects and develop mitigations to meet the established VRM objectives.

The BLM Visual Resource Inventory Handbook (Handbook 8410-1; USDI BLM 1986b) sets forth the procedures for inventorying scenic values and establishing VRM objectives, referred to as Management Classes. A visual resource inventory is informational in nature and does not set forth management direction. A visual resource inventory is based on an analysis of three primary criteria influencing visual values: 1) inherent scenic quality, 2) public sensitivity to landscape change, and 3) distance zones from primary travel ways or special areas. These three criteria are ranked for all acres of public land and a final VRM inventory rating is identified.

These ratings are then used during the land use planning process and considered along with other resource objectives to determine final VRM objectives, or classes. BLM policy requires that every acre of BLM land be inventoried and assigned a VRM class ranging from Class I to Class IV. After VRM classes have been established, Bureau policy requires all management activities to be designed to meet the assigned classes. Class IV allows for the most visual change to the existing landscape, while Class I allows the least (Table 3-12).

The Visual Contrast Rating Handbook (Handbook 8431-1; USDI BLM 1986c) is used to provide an objective and consistent method for describing landscape character, evaluating visual effects of activities, and developing mitigation to meet VRM objectives. The contrast rating process involves describing the landscape in the context of the basic environmental design elements and features that comprise it. The elements of form, line, color, and texture are used when describing and evaluating landscapes. Activities or modifications in a landscape that repeat these elements are thought to be in harmony with their surroundings. Modifications that do not harmonize are said to be in contrast with their surroundings. Visual resource design techniques and best management practices (BMPs) are then used in project development to minimize contrast in order to meet the VRM Class objectives established in the LUP.

Wilderness and Other Special Areas

The BLM manages certain lands under its jurisdiction that possess unique and important historical, anthropological, ecological, biological, geological, and paleontological features. These features include undisturbed wilderness tracts, critical habitat, natural environments, open spaces, scenic landscapes, historic locations, cultural landmarks, and paleontologically rich regions. Special management is administered with the intent to preserve, protect, and evaluate these significant components of our national heritage. Most special areas are either designated by an Act of Congress or by Presidential Proclamation, or are created under BLM administrative procedures.

The National Landscape Conservation System is the primary management framework for these specially designated lands. The NLCS was created in June 2000 by the BLM to bring into a single system some of the agency's premier areas. Of the nearly 261 million acres administered by the BLM, nearly 43 million acres on 867 BLM units are managed under the NLCS program (Map 3-12 and Table 3-13). The NLCS designations include National Monuments, National Conservation Areas, Designated Wilderness and WSAs, National Scenic and Historic Trails, and Wild, Scenic, and Recreational Rivers (USDI BLM 2006d).

Fourteen of the 15 BLM-administered National Monuments are areas designated by the President, under the authority of the Antiquities Act of 1906, for the protection of objects of scientific and historical interest that are located on federal lands. Congress has also created a BLM National Monument on which to conserve, protect, enhance and manage public lands. National Conservation Areas, Cooperative Management and Protections Areas, Outstanding Natural Areas, National Recreation Areas, and Forest Reserves are designated by Congress to conserve, protect, enhance, and manage public land areas for the benefit and enjoyment of present and future generations. These 13 areas, totaling 14 million acres, feature exceptional natural, recreational, cultural, wildlife, aquatic, archeological, paleontological, historical, educational, and scientific resources. Additionally, the White Mountains National Recreation Area in Alaska is approximately 1 million acres and was designated by the Alaska National Interest Lands Conservation Act of 1980. The White Mountains National Recreation Area

TABLE 3-12
Visual Resource Management (VRM) Classes, Objectives, and Appropriate Management Activities

VRM CLASS	Visual Resource Objective	Change Allowed (Relative Level)	Relationship to the Casual Observer
Class I	Preserve the existing character of the landscape. Manage for natural ecological changes.	Very Low	Activities should not be visible and must not attract attention.
Class II	Retain the existing character of the landscape.	Low	Activities may be visible, but should not attract attention.
Class III	Partially retain the existing character of the landscape.	Moderate	Activities may attract attention but should not dominate the view.
Class IV	Provide for management activities which require major modification of the existing character of the landscape.	High	Activities may attract attention, may dominate the view, but are still mitigated.

is managed for multiple uses with an emphasis on recreational uses (USDI BLM 2006c).

National Wilderness Areas, designated by Congress, are defined by the Wilderness Act of 1964 as places "where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Designation is aimed at ensuring that these lands are preserved and protected in their natural condition. Wilderness Areas, which are generally 5,000 acres or more in size, offer outstanding opportunities for solitude or a primitive and unconfined type of recreation; such areas may also contain ecological, geological, or other features that have scientific, scenic, or historical value. The BLM manages 175 Wilderness Areas encompassing nearly 7.2 million acres (USDI BLM 2006d).

Wilderness Study Areas have been designated by the BLM as having wilderness characteristics, thus making them worthy of consideration by Congress for wilderness designation. Currently, the BLM manages 610 WSAs encompassing 14.3 million acres. While Congress considers whether to designate a WSA as permanent wilderness, the BLM manages the area to prevent impairment of its suitability for wilderness designation.

National Wild and Scenic Rivers (WSRs) are rivers (or river sections) designated by Congress or the Secretary of the Interior, under the authority of the Wild and Scenic Rivers Act (WSRA) of 1968, to protect remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values and to preserve the river in its free-flowing condition. The law recognizes three classes of rivers—wild, scenic, and recreational. Wild rivers are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and water unpolluted. Scenic rivers are free of impoundments with shorelines or watersheds largely undeveloped, but accessible in places by roads. Recreational rivers are readily accessible by road or railroad, may have some development along their shoreline, and/or may have undergone some impoundment or diversion in the past. The BLM manages all or portions of 38 rivers totaling 2,052 miles as part of the National WSR System (USDI BLM 2006d).

Congress, under the National Trails System Act of 1968, designates areas as National Scenic and Historic Trails. National Scenic Trails offer maximum outdoor recreation potential and provide enjoyment of the various qualities (scenic, historical, natural, and cultural) of the areas through which these trails pass. National Historic Trails are extended trails that follow as closely as possible, on federal land, the original trails or routes of travel with national historical significance. Designation identifies and protects historic routes and their historic remnants and artifacts for public use and enjoyment. A designated trail must meet certain criteria, including having a significant potential for public recreational use or interest based on historical interpretation and appreciation.

The NLCS differs from the National Park System and the National Wildlife Refuge System in several ways. Visitor facilities are often located in adjacent communities, providing local economic opportunities and minimizing new development in the special areas. Traditional land uses, such as livestock grazing, are often permitted in these areas, and the local communities and interested public are encouraged to participate in the planning and management of them. Other special areas managed by the BLM outside of the NLCS framework include Areas of Critical

Environmental Concern (ACEC), Research Natural Areas, National Natural Landmarks, National Recreation Trails, and a variety of other area designations.

The BLM uses the ACEC designation to highlight public land areas where special management attention is necessary to protect and prevent irreparable damage to important historical, cultural, and scenic values; fish or wildlife resources; or other natural systems or processes.

The ACEC designation may also be used to protect human life and safety from natural hazards. The BLM identifies, evaluates, and designates ACECs through its resource management planning process. Allowable management practices and uses, mitigation, and use limitations, if any, are described in the planning document.

Under current guidelines, ACEC procedures also are used to designate Research Natural Areas, Outstanding Natural Areas, and other natural areas requiring special management attention. The National Natural Landmarks Program recognizes and encourages the conservation of outstanding examples of natural history. National Natural Landmarks are designated by the Secretary of the Interior and are the best examples of biological and geological features in both public and private ownership within the U.S. The Recreational Trails Program provides funds to the states to develop and maintain recreational trails and trail-related facilities for both non-motorized and motorized recreational trail uses.

Among these groups, 903 areas comprising nearly 13 million acres are designated as ACECs; 45 areas comprising over 417,000 acres are designated as National Natural Landmarks; and 164 areas comprising over 323,000 acres are designated as Research Natural Areas. An additional 30 million acres fall under various other designations, such as the Lake Todatonten Special Management Area, the Santa Rosa Mountains National Scenic Area, Herd Management Areas, and Globally Important Bird Areas. In addition, there are over 2,950 miles of vehicle routes and trails designated as National Backcountry Byways and National Recreation Trails (USDI BLM 2006b, c).

The BLM also cooperates with the National Park Service in implementing the National Natural Landmark Program as it applies to public lands. The National Park Service, through the National Natural Landmark Program, designates significant examples of the Nation's ecological and geological heritage.

Recreation

Public lands provide visitors with a wide range of recreational opportunities, including hunting, fishing, camping, hiking, dog mushing, cross-country skiing, boating, hang gliding, OHV driving, mountain biking, birding, viewing scenery, and visiting natural and cultural heritage sites. In addition to the recreational opportunities afforded the public by wilderness and other special areas discussed earlier, the BLM administers 205,498 miles of fishable streams, 2.2 million acres of lakes and reservoirs, 6,600 miles of floatable rivers, over 500 boating access points, 300 Watchable Wildlife sites, 55 National Back Country Byways, 5,500 miles of National Scenic, Historic, and Recreational Trails, and thousands of miles of multiple use trails used by motorcyclists, hikers, equestrians, and mountain bikers (USDI BLM 2006c).

The BLM's long-term goal is to provide opportunities to the public for environmentally responsible recreation. Over 4,000 communities with a combined population of 23 million people are located within 25 miles of public lands, and approximately 40% of public lands are located within a day's drive of a major urban area (USDI BLM 2006c).

Most BLM lands are managed as Extensive Recreation Management Areas (ERMAs), where management consists primarily of providing basic information and access. Dispersed recreation occurs in ERMAs, and visitors have the freedom of recreational choice with minimal regulatory constraints. Significant public recreation issues or management concerns are limited in these areas, and nominal management suffices.

Special Recreation Management Areas (SRMAs) are places where special or intensive recreation management is needed. SRMAs include congressionally recognized areas, such as WSRs, parts of the National Trail System, National Recreation Areas, and Wilderness Areas. In addition, administratively recognized areas where issues or management concerns may require special or intensive management are also designated. Areas where visitor use may cause user conflicts, visitor safety problems, or resource damage are also included. These more intensively used areas require direct supervision of recreational activities and of commercial and BLM-regulated recreation operations. Most SRMAs require selective vegetation treatments to protect visitors from hazards and/or adverse effects associated with certain plants, and

TABLE 3-13
National Landscape Conservation System and Other Special Designation Areas on Public Lands as of September 2005

State	National Landscape Conservation System Area														Non-NLCS Area	
	Outstanding Natural Areas, Forest Reserve Cooperative Management and Protection Areas, and National Recreation Areas		National Monuments		National Conservation Areas		Wilderness Areas		Wilderness Study Areas		Wild, Scenic, and Recreational Rivers		National, Historic, and Scenic Trails		Acres of Critical Environmental Concern	
	# of Sites	Acres	# of Sites	Acres	# of Sites[1]	Acres[2]	# of Sites[1]	Acres	# of Sites[1]	Acres	# of Sites	Acres/Miles	# of Sites[1]	Mi^2	# of Sites	Acres
Alaska	1	998,772	-	-	1	1,208,624	-	-	1	784,238	6	609,280/952	1	418	41	4,545,920
Arizona			5	1,775,017	3	121,277	47	1,396,466	2	63,930	-	-	2	1,003	50	638,110
California	1	7,400	3	291,390	3	10,729,231	76	3,552,665	77	974,769	6	24,800/78	4	1,690	147	3,441,407
Colorado			1	163,892	2	185,773	4	139,524	54	621,737	-	-	-	-	68	648,166
Idaho			1	274,800	1	484,034	1	802	66	1,341,709	-	-	4	1,472	95	580,973
Montana			2	375,027	-	-	1	6,000	40	450,823	1	89,300/149	3	-	43	248,576
Nebraska			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nevada			-	-	3	1,043,422	38	1,758,613	71	2,877,917	-	-	1	711	36	1,358,234
New Mexico			1	4,124	1	227,100	3	139,281	60	970,532	2	22,720/71	3	60	151	595,001
North Dakota			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oklahoma			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oregon	2	428,156	1	52,947	-	-	4	186,723	97	2,337,762	23	254,438/803	3	-	200	894,135
South Dakota			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Texas			-	-	-	-	-	-	-	-	-	-	1	-	-	-
Utah			1	1,870,800	1	-	3	27,720	99	3,260,120	-	-	3	-	59	1,267,389
Washington			-	-	-	-	1	7,140	1	5,518	-	-	-	-	-	-
Wyoming			-	-	-	-	-	-	42	575,841	-	-	6	213	38	696,894
Total	4	1,434,328	15	4,807,997	13	13,999,461	175	7,214,934	610	14,264,896	38	1,005,538/2,052	12	5,567	928	14,914,805

[1] Figures in the number column do not add up to the total shown at the bottom since areas may cross state lines and are reported in the count for each state.
[2] Acreages/miles for multi-state sites are provided only for the state in which the majority of site is located.
Source: BLM Public Land Statistics (USDI BLM 2006d).

replanting of vegetation in highly disturbed areas to improve appearance.

BLM field offices reported 56 million recreational visits to BLM public lands and waters in FY 2005, an increase of nearly 4% from the previous year. The total amount of time spent on public lands, reported as visitor days, was estimated at 66.2 million visitor days, down 5% from the previous year (Table 3-14; USDI BLM 2006d). The greatest number of visitor days occurred in Arizona and California. Overall, developed recreational sites were used about as frequently as non-developed dispersed areas. Recreational use of public lands consists predominately of camping and picnicking, which represented 43% of all visitor days in 2005. Other important recreational activities include non-motorized travel, such as hiking, horseback riding, and mountain biking (10%); off-highway travel (10%); hunting (8%); and viewing public land resources and interpretation and education (6%). The remaining visitor days were associated with driving for pleasure, special events, sports and activities, power and non-power boating, fishing, and swimming. Snow- and ice-based activities, such as cross-country skiing, snowmobiling, and snowshoeing, represented less than 1% of visitor days (USDI BLM 2006c).

Commercial revenues generated by recreation on BLM lands are discussed in the Social and Economic Values section of this chapter.

TABLE 3-14
Estimated Recreation Use of Public Lands during Fiscal Year 2005

State	Number of Visitor Days[1] (thousands)		
	Recreation Sites	Dispersed Areas	Total[2]
Alaska	297	921	1,218
Arizona	7,541	1,776	13,958
California	8,426	8,776	17,246
Colorado	1,637	3,021	4,776
Idaho	1,234	2,847	4,102
Montana, North Dakota, and South Dakota	920	2,528	3,448
Nevada	915	4,644	5,560
New Mexico, Oklahoma, and Texas	581	1,416	1,997
Oregon and Washington	2,015	3,712	5,727
Utah	1,912	3,883	6,226
Wyoming and Nebraska	630	1,258	1,890
Total	26,108	34,782	66,178

[1] One visitor day equals 12 visitor hours.
[2] Includes visitor days for recreation lease sites and recreation partnership sites.
Source: BLM Public Land Statistics (USDI BLM 2006d).

Rights-of-way, Facilities, and Roads

Rights-of-way

Rights-of-way Under FLPMA and the Mineral Leasing Act provisions, the BLM issues ROW grants to authorize the construction, operation, and maintenance of a wide range of projects on public lands. These include petroleum pipelines, electrical transmission lines, telecommunications lines, energy development and distribution facilities, water facilities, communication sites, and roads. Rights-of way for roads, trails, and other infrastructure needs are appropriated for use by the BLM and other federal agencies (e.g., Forest Service, Federal Highway Administration, and Bonneville Power Administration) under Section 507 of FLPMA.

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The length and width of an ROW (and the resulting acreage of public lands) is dependant on a variety of physical and operational factors, including topography,

geology, safety, type of use or uses proposed within the ROW, current technology, and access needs. Rights-of-way may also be subject to controls or limitations prescribed by law or identified within BLM land use plans. The BLM encourages the utilization of ROWs in common, where practical, in order to minimize adverse environmental impacts. The BLM land use plans identify ROW corridors for existing and future ROW development.

Rights-of-way are issued for short-term use of public lands or in perpetuity. Right-of-way grants generally include provisions that authorize the holder to manage vegetation within and adjacent to the ROW using methods approved by the BLM. The scope and intensity of vegetation management treatments within ROWs are operationally specific and highly variable. Inspections are conducted at periodic intervals to assess vegetation treatment needs within the ROW. Several techniques are used to manage vegetation in ROW. Preemergence or postemergence herbicides can be applied to prevent or control young emerging and existing vegetation. Mechanical methods, such as mowing, are also used to eliminate undesirable vegetation. In certain situations, livestock have been used to selectively remove undesirable plant species, in a targeted approach. Vegetation can interfere with ROW site access and facility maintenance, interfere with electric power flow, and pose safety problems for workers and other users of ROW. The development and maintenance of ROW has significant impacts on vegetation. The removal of the existing vegetation during construction activities results in increases in bare ground that can facilitate the introduction and spread of non-native and invasive plant species. The relatively open nature of ROW makes them attractive to many recreationists, including OHV enthusiasts, horseback riders, and hikers. However these activities can also facilitate the spread of invasive species that are present on ROW.

Facilities and Roads

The BLM operates or oversees operation on numerous facilities on public lands. These include oil, gas, geothermal, and mineral exploration and production sites, including over 21,000 production sites; 510 campgrounds, 87 interpretive centers, and other recreational facilities; over 4,300 buildings and 713 administrative sites; over 76,000 miles of roads; and communication facilities (USDI BLM 2006c).

Construction and operations disturbance can often introduce noxious weeds and other invasive vegetation to facility sites and roads. In general, vegetation management at facilities focuses on controlling vegetation that can pose a safety or fire hazard, or is not aesthetically pleasing. In such situations the vegetation is managed using several methods, which can be integrated into an effective management process. Residual herbicides, applied to vegetation before or after emergence, offer extended management in areas where bare ground is required for safety purposes. Mechanical methods, such as mowing, and manual control by hand pulling have been used to manage vegetation along roads, as well as in sensitive areas.

Social and Economic Values

Social/Demographic Environment

The western U.S., including Alaska, is more sparsely populated than the rest of the U.S., containing about 32% of the total U.S. population, but comprising approximately 65% of the total land area. In 2000, over 89 million people lived in this region, with over 50 million in California and Texas, alone (Table 3-15). Population density is relatively low, averaging about 40 people per mi^2, which is half of the national average of nearly 80 people per mi^2. Density ranges from about 1 person per mi^2 in Alaska to over 217 persons per mi^2 in California. Based on 2000 census data, population growth between 1990 and 2000 averaged over 16%, which was slightly higher than the national average. Many of the western states, however, exceeded the national average, with growth rates of 20% or higher during this time period.

Within regions of the western states, mobility patterns of the population were evident. Population declined in rural areas and increased in urban areas. Growth of the western states during this time occurred predominantly in WUI areas, due to expansion of urban population areas into previously rural areas.

The western U.S. contains a large percentage of the nation's minority populations, including over 60% of the nation's Hispanics and American Indians, and over 50% of the nation's Asian/Pacific Islanders. In particular, Arizona, California, New Mexico, and Texas contain large Hispanic populations, which comprise from 25 to over 40% of the total population in each of these states. Over 15% of Alaska's population is comprised of American Indians.

The age distribution of the population of the western U.S. is similar to the nationwide distribution.

Approximately 27% of the population is under 18 years of age, while about 11% is over 65. Alaska and Utah are slight exceptions, with a higher percentage of people under 18 (over 30%) and a lower percentage of people over 65 (5% and 8%, respectively).

Economic Environment

Employment

Between 1990 and 2000, employment growth in the western U.S. averaged 21%, which slightly exceeded the national average of about 18%. Nevada and Arizona had the most employment growth overall (60% and 42%, respectively) while California and Alaska had below-average employment growth of less than 15%. Most employment growth during this time occurred in the management, professional, and related occupations (26%) and in the service sector (15%), while negligible growth occurred in the manufacturing sector.

In December 2006, the nationwide unemployment rate was 4.5% (Table 3-16). Unemployment rates in the western U.S. exceeded the national average, with the greatest unemployment in Alaska (6.7%), Oregon (5.4%), and Washington (5.0%). The unemployment rate was lowest in Utah (2.6%) and Montana (2.9%; U.S. Department of Labor Bureau of Labor Statistics 2007). Unemployment rates were generally higher for African Americans and Hispanics than other races.

Over 23% of the nation's employment opportunities, amounting to over 40 million jobs, are located in the western U.S. (Table 3-17). Employment in the trade and services industries accounts for over half of the total jobs. Industries related to natural resources, such as agriculture and mining, are important sources of employment and represent nearly one third of the nation's agricultural services, forestry, and fishing jobs. Employment in the government and military sector is higher in Alaska than in other states, accounting for 27% of total jobs versus about 17% overall in the western U.S.

Income

In 2000, the per capita income in the western U.S. was $20,215, which was similar to the national average of $21,690. Per capita income was greatest in Colorado, Washington, Alaska, and California, and lowest in Montana, Idaho, and Utah. In 1999, approximately 12% of the population of the western U.S. lived below the poverty level, which was consistent with the national average. The highest poverty rates occurred in Montana, California, and Arizona, while the lowest rates occurred in Alaska, Colorado, and Utah (U.S. Department of Commerce Bureau of the Census 2004).

In 1999, the highest mean annual income in the western U.S. was paid to individuals employed by the federal government ($63,048), followed by the mining ($57,458), transportation and public utilities ($50,397), and manufacturing ($50,201) sectors. The lowest average income was realized by those working in the agricultural services, forestry, and fishing ($18,845) and retail trade ($20,332) industries (U.S. Department of Commerce Bureau of the Census 2004).

Revenues Generated by BLM Lands

The BLM allows land use for authorized private commercial activities such as energy and mineral commodity extraction, timber harvesting, livestock grazing, recreation, and the development of ROW on public land. Income generated by public land is used to assist state and local governments, support the General Fund of the U.S. Treasury, and offset charges for program operations where certain fees collected can be retained by the BLM. During FY 2005, the BLM collected nearly $1.6 billion from a variety of land uses in the western U.S. (Table 3-18).

Operating revenues from mineral leases and permits totaled $178.3 million in FY 2005 (USDI BLM 2006c). These receipts include rental collections from oil and gas ROW, revenues from developed lands within the Naval Oil Shale Reserve in Colorado, lease rentals and bonus bids from the National Petroleum Reserve in Alaska, and fees related to mining claims, holding fees, and non-operating revenues.

Woodland products are an important commodity and source of revenue generated on public lands. These products include timber; other wood products, such as fuelwood, posts, and poles; and non-wood forest products, such as Christmas trees, cactus, seed, yucca, pinyon nuts, mushrooms, and yew bark. During FY 1997 to 2005, an average of approximately $35 million was generated annually from woodland products harvested from public lands, the majority of which came from timber sales. The average volume of timber harvested annually between 1997 and 2005 was approximately 30 million cubic feet. The revenue generated from timber sales has generally decreased over the past 8 years, from $83.6 million in 1997 to $36.1 million in 2005 (USDI BLM Public Land Statistics 1997-2006).

TABLE 3-15
Population, Age Distribution, and Race in the Western States and Alaska

State	Population 2000 (thousands)	Percent Change from 1990	Density (per mi²)	Age Distribution		Percent of Hispanic Origin	Percent of Both Hispanic and Non-Hispanic Origin					
				Percent Under 18	Percent Over 65		Caucasian	African American	American Indian	Asian/Pacific Islander	Other	More than 1 Race
Alaska	627	12.3	1.1	30.2	5.4	4.1	69.3	3.5	15.6	4.5	1.6	5.4
Arizona	5,131	28.6	45.2	26.5	12.6	25.3	75.5	3.1	5.0	1.9	11.6	2.9
California	33,877	12.1	217.2	27.2	10.1	32.4	59.5	6.7	1.0	11.2	16.8	4.7
Colorado	4,301	23.4	41.5	25.5	9.2	17.1	82.8	3.8	1.0	2.3	7.2	2.8
Idaho	1,294	22.2	15.6	28.4	10.7	7.9	91.0	0.4	1.4	1.0	4.2	2.0
Montana	902	11.4	6.2	25.3	12.5	2.0	90.6	0.3	6.2	0.6	0.6	1.7
Nebraska	1,711	8.4	22.3	26.3	13.6	5.5	89.6	4.0	0.9	1.3	2.8	1.4
Nevada	1,998	39.9	18.2	25.5	10.6	19.7	75.2	6.8	1.3	4.9	8.0	3.8
New Mexico	1,819	16.7	15.0	27.8	11.2	42.1	66.8	1.9	9.5	1.2	17.0	3.6
North Dakota	642	0.5	9.3	24.9	13.5	1.2	92.4	0.6	4.9	0.6	0.4	1.2
Oklahoma	3,460	9.7	50.3	25.9	13.2	5.2	76.2	7.6	7.9	1.5	2.4	4.5
Oregon	3,421	16.9	35.6	24.6	12.2	8.0	86.6	4.6	1.3	3.2	4.2	3.1
South Dakota	755	7.8	9.9	26.5	13.1	1.4	88.7	0.6	8.3	0.6	0.5	1.3
Texas	20,852	22.8	79.6	28.2	9.9	32.0	71.0	11.5	0.6	2.8	11.7	2.5
Utah	2,233	22.9	27.2	32.0	8.2	9.0	89.2	0.8	1.3	2.4	4.2	2.1
Washington	5,894	17.4	88.6	25.6	10.6	7.5	81.8	3.2	1.6	5.9	3.9	3.6
Wyoming	494	8.1	5.1	25.9	11.0	6.4	92.1	0.8	2.3	0.7	2.5	1.8
United States	281,422	11.6	76.6	25.6	11.7	12.5	75.1	12.3	0.9	3.7	5.5	2.4
Western States	89,406	16.5	40.5	27.1	10.5	24.9	70.7	6.5	1.9	6.0	11.4	3.6
Percentage of Total U.S.	31.8	-	-	33.7	28.5	63.2	29.9	16.7	68.3	50.3	66.3	46.7

Source: U.S. Department of Commerce Bureau of the Census (2004).

TABLE 3-16
Percent Unemployment for Western U.S. and Alaska

State	Year		
	1990	2000	December 2005
Alaska	7.0	6.6	6.7
Arizona	5.5	3.9	4.1
California	5.8	4.9	4.8
Colorado	5.0	2.7	4.0
Idaho	5.9	4.9	3.2
Montana	6.0	4.9	2.9
Nebraska	2.2	3.0	3.1
Nevada	4.9	4.1	4.4
New Mexico	6.5	4.9	3.8
North Dakota	4.0	3.0	3.2
Oklahoma	5.7	3.1	3.8
Oregon	5.6	4.9	5.4
South Dakota	3.9	2.3	3.2
Texas	6.3	4.2	4.5
Utah	4.3	3.2	2.6
Washington	4.9	5.2	5.0
Wyoming	5.5	3.9	3.0
United States	5.6	4.0	4.5
Source: U.S. Department of Labor Bureau of Labor Statistics (2007).			

Ninety percent of income from the sale of timber and other vegetative materials is derived from Oregon and California and Coos Bay (Oregon) Wagon Road Grant Lands. Timber harvest levels on these lands are guided by the direction of the Northwest Forest Plan. Timber sales on other public lands include sales from salvage timber and forest health projects.

Grazing fees are derived using a formula established in the *Public Rangelands Improvement Act of 1978*, which is based on several index factors, including private land lease rates, beef cattle prices, and the cost of production. In 2006, the fee was $1.56 per AUM, down from $1.79 in 2005 (USDI BLM 2006c). Approximately $14.5 million was collected in grazing receipts in 2005. Half of the grazing fees are used by the BLM for rangeland improvements (USDI BLM 2006d).

Fees are charged at many public recreation sites to provide for maintenance and improvement, and include access fees for Entrance Permits, Special Area Permits, Daily Use Permits, Commercial, Competitive, and Group Permits, Leases, and Passports. At other locations, generally those without public facilities, no fees are charged. In FY 2005, nearly 79% of recreational use on public lands, in terms of visitor days, occurred in non-fee areas (USDI BLM 2006d). The BLM also issues special recreation permits to qualified commercial companies and organized groups such as outfitters, guides, vendors, and commercial competitive event organizers who conduct activities on both fee and non-fee lands. Nearly $13.3 million were collected in recreation fees in 2005 (USDI BLM 2006d).

In FY 2005, sales of public land and material, including receipts from the sale of public land, and the sale of vegetative and mineral materials, totaled nearly $1.5 billion, of which nearly $1.2 billion were from the sale of certain public lands in Clark County, Nevada, near the city of Las Vegas, under the *Southern Nevada Public Land Management Act* (USDI BLM 2006c).

In addition to providing revenue for the BLM, all of the major public land activity categories generate economic benefits to the communities and states in which they occur. For example, there are nearly 18,000 grazing leases in force on public lands, supporting over 12.7 million AUMs (Table 3-6). Alaska and Texas have no grazing permits in force. The value of these grazing permits and the acreage they entail vary widely depending on the location, soil characteristics, and precipitation. The availability of public land grazing leases is highly beneficial, if not crucial, to some ranching operations, however, and consequently is very important to many rural communities throughout the West.

Similarly, mineral development is an economic mainstay of many western communities. Table 3-17 illustrates the relative importance to the employment base of mineral extraction, particularly in Arizona, Wyoming and Nevada. Each of these states, plus Alaska, has a much higher percentage of employment in mining/natural resource industry than the average for the West as a whole. This industry sector includes oil and gas, coal, aggregates, and hard rock minerals such as gold and copper. Alaska's oil industry not only supports ongoing employment, it contributes toward minimizing taxes for all state residents and has provided a substantial cash rebate to residents over the years.

The BLM estimated the benefits to local economies from recreation on public lands. These estimates serve as one example of the economic activity that depends on the public land base. Recreational activity provides revenue for local economies through expenditures associated with activities such as hunting, fishing, and wildlife viewing (Table 3-19). In FY 2005, an estimated $3 billion was injected into local economies through these recreation-associated expenditures (USDI BLM 2006c, d). These activities produce indirect financial

TABLE 3-17
Percent Employment by Industry in 2004

State	Agriculture	Mining and Natural Resources	Construction	Manufacturing	Transportation and Public Utilities	Trade (wholesale and retail)	Finance, Insurance, and Real Estate	Services	Government	Other	Total Number (thousands)
Alaska	0.3	3.5	6.5	3.5	20.6	13.8	4.8	7.7	27.4	3.6	301
Arizona	2.7	8.6	8.4	7.2	19.0	15.8	6.8	14.0	17.6	3.7	2,379
California	3.1	0.2	5.8	10.5	18.9	15.5	0.6	15.1	16.4	3.4	14,633
Colorado	2.0	0.7	7.0	7.0	18.7	15.3	7.1	13.9	16.7	4.0	2,186
Idaho	6.5	0.8	7.3	10.3	19.8	16.5	4.6	12.9	19.7	3.1	600
Montana	6.5	1.7	6.5	4.6	20.8	17.0	5.2	8.4	21.4	4.0	410
Nebraska	6.9	0.1	5.3	11.0	21.6	16.1	6.9	10.3	17.8	3.8	917
Nevada	1.4	7.8	10.2	4.0	17.0	14.1	5.4	8.1	14.0	3.0	1,165
New Mexico	2.5	1.9	6.4	4.6	17.3	14.4	4.4	11.4	25.3	3.6	799
North Dakota	8.8	1.1	5.4	7.0	21.3	17.4	5.6	7.1	23.0	4.6	341
Oklahoma	3.3	2.2	4.3	9.7	18.8	15.2	5.7	10.8	20.5	5.0	1,472
Oregon	4.3	0.6	5.3	12.6	19.9	16.4	6.1	11.1	17.0	3.6	1,624
South Dakota	9.2	0.2	5.4	9.9	20.3	17.2	7.2	6.2	19.7	4.2	385
Texas	2.9	1.6	5.9	9.3	20.6	16.4	6.2	11.3	17.7	3.8	9,519
Utah	2.4	0.7	6.8	10.3	19.8	15.7	5.8	12.6	18.0	2.9	1,119
Washington	2.9	0.3	6.3	9.6	19.2	15.8	5.8	11.2	19.3	3.7	2,752
Wyoming	5.5	8.1	8.2	3.8	19.1	14.4	4.1	6.0	25.4	3.7	259
Western U.S.	3.2	0.8	5.8	9.3	19.5	15.8	6.1	12.8	17.6	3.6	40,861

Source: U.S. Department of Labor Bureau of Labor Statistics (2004).

benefits to community businesses providing food, lodging, equipment sales, transportation, and other services. State fish and wildlife management agencies also benefit from spending associated with these activities from sources such as state tax revenue and state administered fishing and hunting license programs.

Expenditures by the BLM

The budget for the BLM was $1.78 billion in FY 2006, and is projected to be $1.8 billion in FY 2007 (USDI BLM 2006c). In FY 2006, $848 million was allocated to management of lands and resources (Table 3-20). These expenditures included integrated management of public land, renewable and cultural resources, fish and wildlife, threatened and endangered species, recreation, and energy and minerals.

Wildland Fire Management

While the amount budgeted for wildland fire management may be relatively consistent from year to year, the cost of fighting fires has varied substantially. The USDI allocated $800 million to wildland fire management for FY 2006 for all USDI fire efforts (USDI BLM 2006c).

Table 3-21 shows the BLM's fire suppression expenditures for recent years. The variability often results from changing weather, but terrain, vegetation, and proximity to populated areas all contribute to the cost of fighting a fire.

The cost of fire suppression also depends on the number and size of fires. Approximately 95% of wildland fires are controlled in the initial attack, when they are relatively small and not yet seriously out of control. Table 3-22 illustrates the acreage lost to large fires (greater than 10,000 acres) in recent years. Notably, there were relatively few large fires in 2001 and 2003, which likely contributed to reduced suppression expenditures in those years. 2004 was an anomaly in that costs remained relatively low despite an extremely large acreage lost to fire. The most likely reason is that

TABLE 3-18
Revenues Generated from Public Lands by Source for Fiscal Year 2005

State	Mineral Leases	Timber Sales	Land and Material Sales	Grazing Fees	Recreation Fees	Other[1]	Total
Alaska	$64,139,369	$17,490	$202,736	$0	$260,115	$801,390	$65,421,100
Arizona	91,485	2,675	2,509,213	769,358	1,217,641	1,828,752	6,419,124
California	220,665	1,605,477	1,388,651	267,679	3,347,666	2,815,390	9,645,528
Colorado	15,499,973	38,502	640,191	617,622	424,138	667,176	17,887,602
Idaho	31,700	558,581	218,056	1,622,749	579,963	828,918	3,839,967
Montana	2,517,912	610,113	139,909	2,039,872	307,467	221,436	5,836,709[2]
Nebraska	0	0	0	1,510	0	0	1,510
Nevada	130,948	6,441	1,240,628,540	2,101,628	2,140,736	4,838,503	1,249,846,796
New Mexico	957,739	14	3,739,748	2,174,496	396,957	721,915	7,990,869
North Dakota	2,172	0	1,573	18,731	0	2,460	24,936
Oklahoma	13,834	0	0	236	0	0	14,070
Oregon	14,861	23,507,514	271,822	1,278,627	1,980,602	1,322,489	28,375,915
South Dakota	201	33,428	1,018	174,142	0	4,601	213,390
Texas	634	0	0	0	0	0	634
Utah	129,034	25	586,121	1,136,093	2,155,660	656,863	4,663,796
Washington	84	10,455	28,165	51,906	0	18,028	108,638
Wyoming	851,335	23,070	1,622,279	2,285,227	218,650	1,026,460	6,027,021
Other	93,700,388[3]	0	0	0	0	0	93,700,388
Total	178,302,334	26,413,785	1,252,024,986	14,539,876	13,029,595	115,754,381	1,498,906,604

[1] Includes fees and commissions, ROW rents, rent of land, and other sources.

[2] Includes Land Utilization Project land purchased by the federal government under Title III of the Bankhead-Jones Farm Tenant Act and subsequently transferred to the USDI.

[3] Includes mining claim and holding fees and non-operating revenue.

Source: BLM Public Land Statistics (USDI BLM 2006d).

TABLE 3-19
Estimated Benefits to Local Economies by Recreation on Public Lands during Fiscal Year 2005

State[1]	Fishing Expenditures	Hunting Expenditures	Wildlife Viewing Expenditures	Total
Alaska	$116,425,359	$22,158,084	$80,372,999	$218,956,442
Arizona	17,251,493	45,326,644	154,080,147	216,658,284
California	54,815,364	82,363,747	411,761,577	548,940,688
Colorado	74,107,778	154,416,602	98,545,120	327,069,500
Idaho	44,282,994	72,746,698	66,800,278	183,829,970
Montana	13,377,194	23,635,550	33,670,436	70,683,180
Nevada	43,973,306	101,344,319	193,650,554	338,968,179
New Mexico	21,802,203	27,218,884	106,404,864	155,425,951
Oregon	60,958,338	140,939,262	219,081,863	420,979,463
Utah	46,208,009	92,412,855	245,410,668	384,031,532
Washington	1,876,536	2,044,106	5,274,085	9,194,727
Wyoming	10,459,904	39,947,204	85,394,947	135,802,055
Total	505,538,478	804,553,955	1,700,447,538	3,010,539,971

[1]Estimates include only states with more than 75,000 acres of public lands. No estimates were made for Nebraska, North Dakota, Oklahoma, South Dakota, and Texas.

Source: BLM Public Lands Statistics (USDI BLM 2006d).

TABLE 3-20
Summary of BLM Jobs and Expenditures for the Management of Lands and Resources Program by Activity and Subactivity (dollars in thousands)

Activity/Subactivity	2005 (Actual)		2006 (Enacted)	
	FTE[1]	Amount	FTE[1]	Amount
Management of Lands and Resources	6,287	$836,826	6,138	$847,632
Land Resources	1,493	188,014	1,456	187,613
Soil, Water, Air	246	34,738	240	33,838
Range Management	6,880	69,183	658	69,870
Forest Management	72	8,895	75	10,404
Riparian Management	195	21,228	190	22,124
Cultural Resources	130	14,925	127	15,015
Wild Horse and Burros	170	39,045	166	36,362
Wildlife and Fisheries	298	36,947	302	40,480
Wildlife Management	197	25,063	202	28,166
Fisheries Management	101	11,884	100	12,314
Threatened and Endangered Species	176	21,144	171	21,254
Recreation	553	60,589	548	65,131
Wilderness Management	145	16,431	141	16,559
Recreation Resource Management	408	44,158	407	48,752
Resource Protection	536	81,501	527	84,358
Energy and Minerals	1,009	106,631	993	108,157
Realty and Ownership	731	92,624	710	88,978
Transportation Facilities and Maintenance	426	77,813	395	76,646
Workforce Organization and Support	626	142,161	611	144,446
Alaska Minerals	15	3,944	11	2,263
Other[2]	663	25,458	639	27,306

[1] Full Time Equivalent.
[2] Includes Communications Sites Management, Mining Law Administration, Land Resources Information Systems, Challenge Cost Share, and Reimbursable programs.
Source: USDI BLM (2006c).

nearly all of the large fires that year were in Alaska, and several were sufficiently remote, or in such rugged terrain, that they were allowed to burn without a major effort to control them.

Hazardous Fuels Reduction

Reducing the hazardous fuels available to sustain a wildland fire can be costly. The USDI treated 542,568 acres in the WUI during 2005 at an average cost of $244 per acre. Treatment can cost up to $5,000 per acre for labor-intensive, small, mechanical treatments in forested WUI areas. During the same year, the USDI treated 726,835 acres in non-WUI areas at a cost of about $104 per acre (USDI-BLM 2006c).

Weed Management

Herbicides and other vegetation management methods are employed to control invasive plant species, which have caused a variety of problems on public lands. The Vegetation section of this chapter addresses several major types of weed infestations on public lands. As Duncan and Clark (2005) noted, "The economic impact of most (weed) species is poorly documented. This is generally due to the lack of quantitative information on ecosystem impacts and the challenge of assessing non-market cost such as those to society and the environment (e.g., changes in fire frequency, wildlife habitat, aesthetics, loss of biodiversity)."

Expenditures for herbicides used on BLM land are a relatively small part of the agency's budget, accounting for only a little more than $2.7 million in FY 2005 (Table 3-23). Table 3-23 includes only the cost of the chemicals; labor and equipment costs for herbicide application are in addition to the costs shown. The BLM estimated it spent $9.6 million to treat approximately 205,000 acres ($47 per acre) to treat weeds during FY 2005; These costs included herbicide, labor, and equipment costs. The cost of herbicides can vary dramatically, depending on the type selected and the

method of application. Costs can also vary significantly by geographic region, vendor, type of chemical (generic versus branded), and size and terrain of the application target area. The Forest Service estimated the average cost per acre at $100 for ground applications and $25 for aerial applications (USDA Forest Service 2005). The BLM's range of estimated application costs is even broader. For ground applications, BLM's estimates range from $50 to $300 per acre for backpack or ATV applications and $25 to $75 per acre for boom sprayer applications. Aerial applications are estimated at $6 to $40 per acre for fixed-wing aircraft and $25 to $200 per acre for helicopter applications.

TABLE 3-21
BLM Wildland Fire Suppression Expenditures Fiscal Year 1998 through Fiscal Year 2005

Fiscal Year	Expenditure	Percent Change from Prior Year
1998	$ 63,470,000	NA
1999	85,724,000	35.1
2000	228,394,000	166.4
2001	192,115,000	-15.9
2002	204,666,000	6.5
2003	151,994,000	-25.8
2004	158,626,000	4.4
2005	218,445,000	39.7

NA = Not applicable
Source: USDI BLM (2006c).

It is estimated that downy brome infests over 56 million acres in the 17 western states and that the infestation is growing at 14% per year (Duncan and Clark 2005). As indicated in Table 3-5, more than 90 million acres of public lands are infested with downy brome and other brome species. Downy brome can increase the frequency and intensity of wildfire and destroy the structure of the native plant communities, particularly sagebrush habitats. Because of its widespread dominance, downy brome has become the most important forage grass in the western U.S. However, it is highly unreliable as a forage base for both cattle and wildlife because it can exhibit "tenfold differences (300-3,500 lbs/acre) from year to year" in productivity, depending on precipitation.

Once a treatment is accomplished, it is then costly to rehabilitate the land. Cost per acre to stabilize and rehabilitate disturbed land is estimated at $17. During 1991, however, it cost $100,000 to rehabilitate the 1,700 acres burned in the Snake River Birds of Prey Area, Idaho, or almost $59 per acre. During 2004, it cost the BLM $1,640 per acre to restore 12,000 acres of forestland and woodlands. The unit cost ranged from $295 per acre in New Mexico to $2,730 per acre in Oregon (USDI BLM 2005a).

TABLE 3-22
BLM Action Fires Larger than 10,000 Acres[1] during 1999 to 2005

Calendar Year	Number of Fires	Average Size (acres)	Total Acreage
1999	64	44,990	2,879,351
2000	66	34,851	2,300,187
2001	28	40,524	1,134,662
2002	46	55,484	2,552,265
2003	23	55,940	1,286,612
2004	51	122,805	6,263,059
2005	98	68,277	6,691,137
Total	376	61,455	23,107,273

[1] Fire Type 1 - All protection types.
Source: USDI BLM (2007c).

Payments to State and Local Governments

Where the federal government maintains public land, it makes payments to state and local governments for a variety of purposes. Receipts from coal leases and bonus payments, for example, are shared. Payments in lieu of taxes help address the loss of potential local tax income that could have been generated from those public lands if they were in private ownership. Payments in lieu of taxes, as well as other forms of transfer payments, are generally set by law and provided according to a formula. Payments in lieu of taxes, for example, are computed based on the number of acres of public lands within each county and multiplied by a dollar amount per acre. Over $2 billion in payments have been made since 1976. Table 3-24 shows the BLM payments to states and local governments for FY 2004.

Human Health and Safety

Background Health Risks

This section discusses background information on human health risks of injuries, and cancer and other diseases for people living in the states in which the BLM is planning to implement vegetation treatments. People living in these states are exposed to a variety of risks common to the U.S. as a whole, including

TABLE 3-23
Herbicide Uses and Costs for Vegetation Treatments on Public Lands during 2005

Herbicide	Type of Application	Acres Treated[1]	Total Herbicide Expenditure[2]	Cost per Acre for Herbicide[2]
2,4-D	Aerial	1,689	$5,474	$3.24
	Ground	40,133	186,515	4.65
Bromacil	Aerial	0	0	NA
	Ground	2,999	379,763	126.63
Chlorsulfuron	Aerial	374	35,572	95.11
	Ground	2,667	51,836	19.44
Clopyralid	Aerial	5,168	169,510	32.80
	Ground	6,277	268,032	42.70
Dicamba	Aerial	48	945	19.69
	Ground	7,664	150,245	19.60
Diuron	Aerial	0	0	NA
	Ground	4,427	72,340	16.34
Fosamine	Aerial	0	0	NA
	Ground	0	0	NA
Glyphosate	Aerial	11,032	25,648	2.32
	Ground	8,309	56,487	6.80
Hexazinone	Aerial	0	0	NA
	Ground	4,952	3,138	0.63
Imazapic	Aerial	0	0	NA
	Ground	45	1,309	29.10
Imazapyr	Aerial	1,203	151,340	125.80
	Ground	1,788	105,619	59.07
Metsulfuron methyl	Aerial	663	5,529	8.34
	Ground	14,129	178,208	12.61
Picloram	Aerial	4,158	67,497	16.23
	Ground	28,385	629,897	22.19
Sulfometuron methyl	Aerial	0	0	NA
	Ground	304	7,741	25.46
Tebuthiuron	Aerial	40,755	47,427	1.16
	Ground	0	0	NA
Triclopyr	Aerial	4,000	23,750	5.94
	Ground	3,170	85,966	27.12

[1] Acres treated do not take into account whether the aerial application was by helicopter or airplane, nor do they distinguish between ground application methods. Costs would vary depending on the application method.
[2] Total herbicide expenditure and cost per acre do not include costs for labor, equipment, and application, and represent an average cost for use throughout the BLM.
NA = Not available or not applicable.

automobile accidents and other injuries; contaminants in the air, water, soil, and food; and various diseases. Risks to workers may differ from those facing the general public, depending on the nature of a person's work. Some of these risks may be quantified, but a lack of data allows for only a qualitative description of certain risks. Where data are only available for the U.S. as a whole, it is assumed that these data apply to the treatment states. Information for this section was obtained from the Centers for Disease Control and Prevention (CDC), the National Center for Injury Prevention and Control (NCIPC), the National Center for Health Statistics (NCHS), the National Institute for Occupational Safety and Health (NIOSH), and the Bureau of Labor Statistics.

TABLE 3-24
BLM Payments to States and Local Governments during Fiscal Year 2005

State	Payments in Lieu of Taxes	Mineral Leasing Act	Taylor Grazing Act[1]			Proceeds of Sales	Other	Total Payments
			Section 3	Section 15	Other			
Alaska	$15,785,027	$29,559	$0	$0	$0	$5,412	$31,594,5953[3]	$47,414,593
Arizona	19,233,774	45,743	43,124	79,669	0	107,081	0	19,509,331
California	19,002,175	122,757	14,012	55,755	0	45,359	0	19,240,058
Colorado	16,839,759	129,557	53,520	30,062	43,068	29,640	0	17,125,606
Idaho	15,871,144	15,850	167,896	22,898	0	18,051	0	16,095,839
Montana	17,188,322	18,056	128,785	95,678	0	20,175	649,745[4]	18,100,761
Nebraska	676,604	0	0	664	0	0	0	677,268
Nevada	13,732,723	65,445	233,458	705	0	824,000	204,497,479[5]	219,353,810
New Mexico	22,386,899	475,204	170,502	135,900	14	88,389	8,269[4]	23,265,177
North Dakota	950,280	1,086	0	7,921	0	67	0	959,354
Oklahoma	1,600,788	13	0	68	0	0	11,946[6]	1,612,815
Oregon	6,428,257	7,678	131,630	23,405	0	46,661	113,338,900[7]	119,976,531
South Dakota	2,566,411	100	0	67,435	0	2,600	0	2,636,546
Texas	2,595,410	317	0	0	0	0	0	2,595,727
Utah	19,622,224	55,319	104,868	0	0	15,337	0	19,797,748
Washington	6,322,087	42	0	22,367	0	5,378	0	6,349,874
Wyoming	14,810,769	413,269	145,697	327,446	6,924	78,040	0	15,782,145
Western States	195,612,593	1,379,995	1,193,49	869,973	50,006	1,286,190	350,100,934	550,493,183
All States	226,356,675	1,379,995	1,193,49	869,973	50,006	1,286,458	350,100,934	581,237,533

[1] Payments in lieu of taxes are made by the USDI, Office of the Secretary, for tax-exempt federal lands administered by the BLM, National Park Service, USFWS, and Forest Service, as well as for federal water projects and some military installations.
[2] Including payments for FY 2004 that were processed in FY 2005.
[3] National Petroleum Reserve – Alaska lands.
[4] Land utilization lands under the Bankhead-Jones Farm Tenant Act (7 U.S.C. 1012).
[5] Land utilization sales under the Southern Nevada Public Land Management Act resulted in direct payments at the time of sale totaling $193,566,000. Calendar year payments to Clark County and the State of Nevada under the Santini-Burton Act totaled $3,784,080.
[6] Oklahoma royalties.
[7] Payments from Oregon and California grant lands and Coos Bay Wagon Road grant land counties.
Source: USDI BLM (2006c).

Risks from Diseases

Disease Incidence

Despite the difficulties in establishing correlations between work conditions and disease, certain illnesses have been linked to occupational hazards. For example, asbestosis and lung cancer among insulation and shipyard workers has been linked to their exposure to asbestos (NIOSH 2002). Pneumoconiosis among coal miners has been correlated with the inhalation of coal dust. Occupational exposures to some metals, dusts, and trace elements, as well as CO, carbon disulfide, halogenated hydrocarbons, nitroglycerin, and nitrates, can result in increased incidence of cardiovascular disease. Neurotoxic disorders can arise from exposure to a wide range of chemicals, including some pesticides. Dermatological conditions like contact dermatitis, infection, trauma, cancer, vitiligo, uticaria, and chloracne have a high occurrence in the agricultural, forestry, and fishing industries.

Disease Mortality

Mortality rates for states in the BLM treatment area are listed in Table 3-25. The five most common causes of death in the U.S., as well as in the treatment states, are heart disease, cancer, stroke, respiratory disease, and accidents (Minino et al. 2002). Counties in the western U.S. that have the highest mortality rates are located in central Nevada, north and south-central California, and western Montana. Mortality rates are generally lowest in counties in western Utah, central Idaho, and northwest Wyoming (NCHS 2007). Mortality rates for males are nearly one and a half times those as for females, and mortality rates for African Americans are nearly one and a half times those of Caucasians (NCHS 2007).

TABLE 3-25
Mortality Rates (per 100,000 population) and Causes of Death by State 2002-2003

State	Cause of Death				
	All[1]	Diseases		Cancer	Accidents
		Cerebrovascular and Cardiovascular Disease	Chronic Respiratory Disease		
Alaska	825.8[2]	245.1	23.2	108.7	54.4
Arizona	787.4	252.7	47.1	172.3	46.6
California	775.1	291.6	37.5	155.8	23.5
Colorado	787.8	234.9	41.4	138.7	38.8
Idaho	798.0	269.8	44.0	158.5	43.3
Montana	840.3	255.5	64.4	216.0	51.7
Nebraska	793.5	298.6	51.3	197.0	36.8
Nevada	922.6	312.2	54.2	181.9	35.2
New Mexico	825.4	253.0	42.3	158.4	55.7
North Dakota	775.9	271.3	48.4	218.5	37.4
Oklahoma	959.7	363.7	55.4	213.6	49.0
Oregon	825.6	261.1	49.7	203.2	37.8
South Dakota	784.8	270.6	51.2	212.7	47.1
Texas	877.8	318.9	23.0	101.5	28.2
Utah	776.8	241.6	49.8	203.8	37.5
Washington	792.9	268.4	70.7	260.1	46.3
Wyoming	851.7	265.6	54.7	186.9	55.1
United States	864.8	305.7	43.2	194.4	35.7

[1]Age-adjusted death rate per 100,000 population, which accounts for changes in the age distribution of the population.
Source: NCHS (2007).

Risks from Injuries

Injury Incidence

In 2005, more than 29.3 million nonfatal injuries were reported in the United States, 4.4 million of which were transportation related (CDC 2007). Injuries accounted for 26% of emergency department visits during 2004 (NCHS 2007).

The rate of hospitalizations for injury is significantly higher among elderly persons than among all other age groups (CDC 2005). The NIOSH estimates that approximately 10 million traumatic work-related injuries occur annually. Some chronic injuries may be directly linked to the nature of the work performed. For example, vibration syndrome affects a large proportion of workers using chippers, grinders, chainsaws, jackhammers, or other handheld power tools, causing blanching and reduced sensitivity in the fingers. The Bureau of Labor Statistics reported that in 1995, an estimated 62% of all work-related illness cases were due to musculoskeletal disorders associated with repeated trauma, such as that associated with the use of power tools (NIOSH 1997). Noise-induced hearing loss may also affect production workers who are exposed to noise levels of 80 decibels or more on a daily basis.

Acute trauma at work remains a leading cause of death and disability among U.S. workers. During the period from 1980 through 1995, at least 93,338 workers in the U.S. died as a result of trauma suffered on the job, with an average of about 16 deaths per day (NIOSH 2001). The *Census of Fatal Occupational Injuries Summary* by the BLS (U.S. Department of Labor Bureau of Labor Statistics 2004) identified 5,559 workplace deaths from acute traumatic injury in 2003. Occupational fatalities resulted from a number of causes, including motor vehicle accidents, machines, falls, homicide, electrocution, and being struck by falling objects (NIOSH 2002).

The occupational fatality rate in 2005 was approximately 4.0 fatalities per 100,000 employed. Fatality rates were highest for the agriculture, forestry, fishing, and hunting; mining; transportation; and construction industries. The fatality rate for the agriculture, forestry, fishing, and hunting sector was the highest, at 32.5 fatal industries per 100,000 workers. The mining sector had the second highest rate, at 25.6

fatalities per 100,000 employed. In the transportation and construction industries the rates were 17.6 and 11.0 fatalities per 100,000 employed, respectively. The largest number of fatal work injuries resulted from construction-related incidents, which accounting for 21% of workplace fatalities in 2003 (U.S. Department of Labor Bureau of Labor Statistics 2004).

Injury Mortality

Over 167,000 Americans died from injuries nationwide in 2004. About 26% of these resulted from motor vehicle accidents, while other accidental deaths occurred from unintentional falls, drowning, and poisoning (CDC 2007). Injury is the leading cause of death and disability among children and young adults.

Risks from Cancer

Cancer Incidence

Nationwide, the chance of developing some form of cancer during one's lifetime is estimated to be about one in four (Calabrese and Dorsey 1984). There are many causes of cancer development, including occupational exposure to carcinogens, environmental contaminants, and substances in food. In the U.S., one-third of all cancers are attributed to tobacco smoking (Chu and Kamely 1988). Work-related cancers are estimated to account for 4% to 20% of all malignancies. It is difficult to quantify the information because of the long time intervals between exposure and diagnosis, personal behavior patterns, job changes, and exposure to other carcinogens. The NIOSH has reported that approximately 20,000 cancer deaths and 40,000 new cases of cancer each year in the U.S. are attributable to occupational hazards. Millions of U.S. workers are exposed to substances that have tested as carcinogens in animal studies (NIOSH 2002).

Cancer Mortality. Based on the data shown in Table 3-25, cancer accounted for between 13 and 33% of all deaths in the treatment states in 2002-2003. Nationwide, cancer account for approximately 23% of all fatalities (NCHS 2007). Cancer mortality rates are generally highest in counties in western and southern Nevada and northern California and lowest in counties in Utah, central Colorado, and northern New Mexico (Devesa et al. 1999), and differ depending on race and sex. Generally, males have higher rates of cancer mortality than females, and African Americans have higher rates than Caucasians.

Risk from Using Herbicides on Public Lands

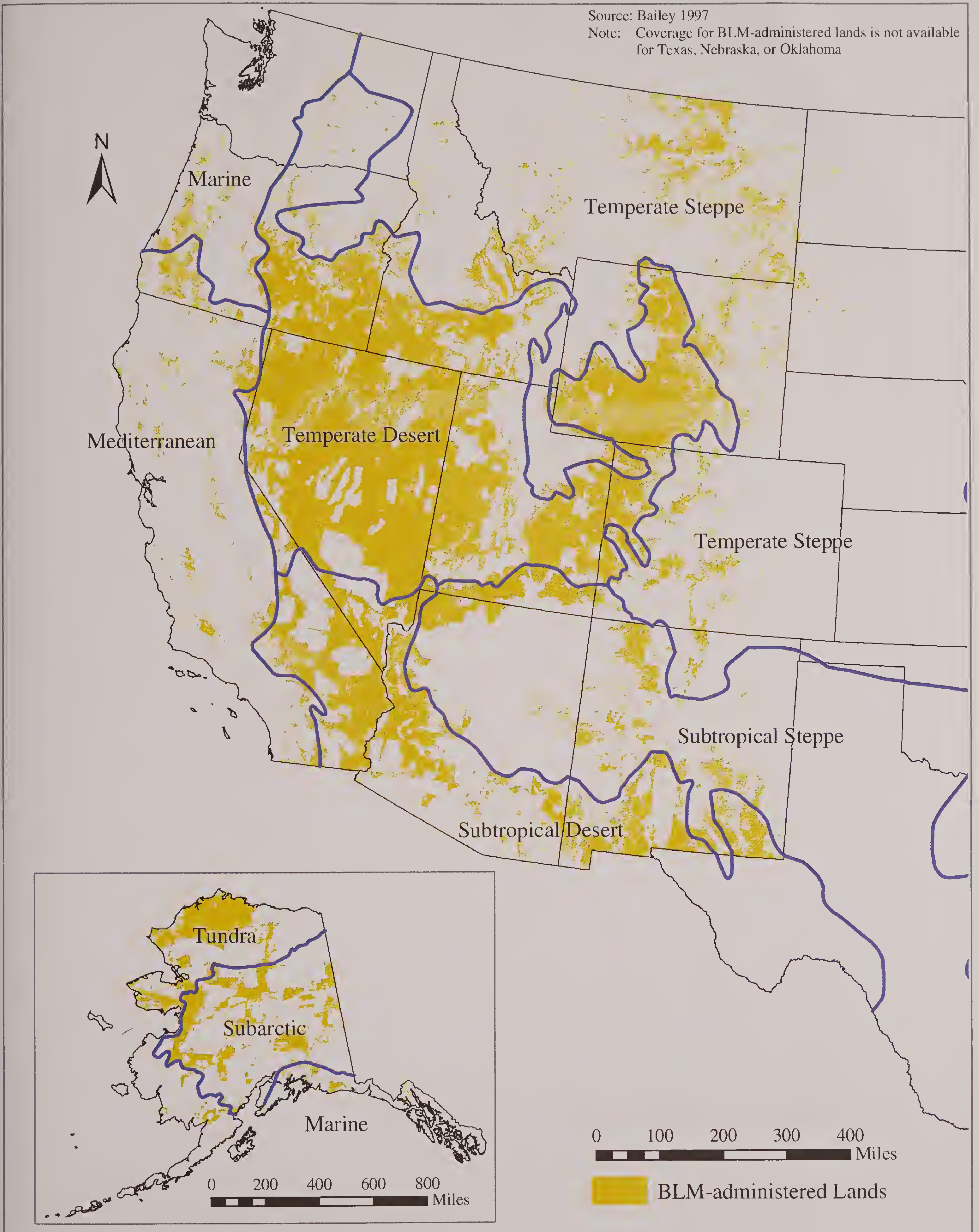
Based on the BLM's injury breakout report (USDI BLM 2005b), only one minor injury from use of herbicides was recorded during FY 2005.

Risk from Wildfire Control on Public Lands

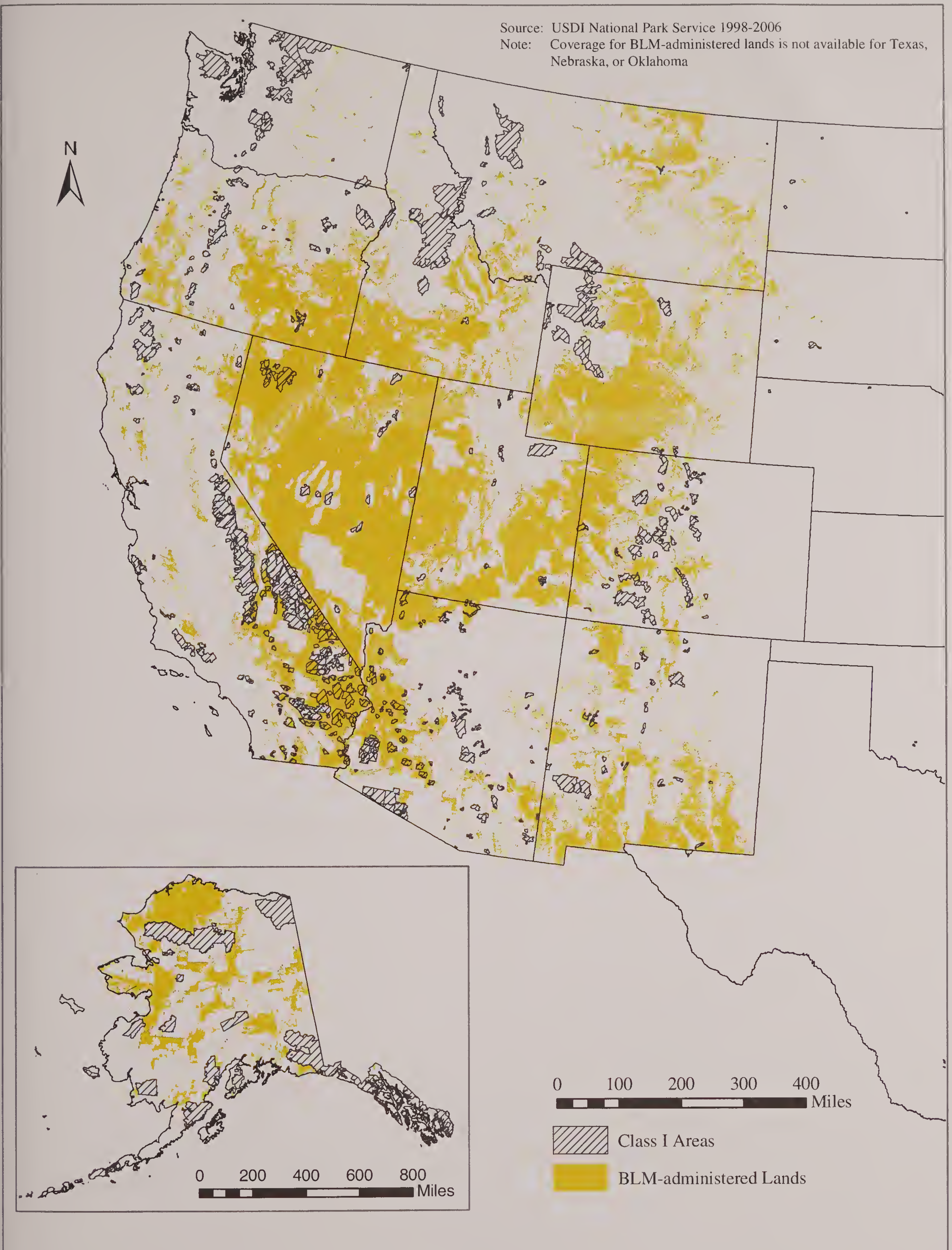
During FY 2005, 24,683 fires totaling 6,691,137 acres were suppressed on public lands. Over three out of every four fires were caused by lightning, while the remainder were caused by humans. Approximately 56% of fires occurred on forestlands, the remainder on rangelands and other land types (USDI BLM 2006d).

Wildfires cause the loss of life and property. According to the National Interagency Fire Center (2005), 12 people died from wildland fire-related accidents in 2005. From 1999 to 2005, the leading cause of firefighter deaths nationally, which include federal, state, and local firefighters and volunteers, as well as private individuals who were involved in direct support of wildland fire operations are: vehicle accidents (23.8%), heart attacks (22.7%), aircraft accidents (22.3%), and burnovers/entrapments (20.2%).

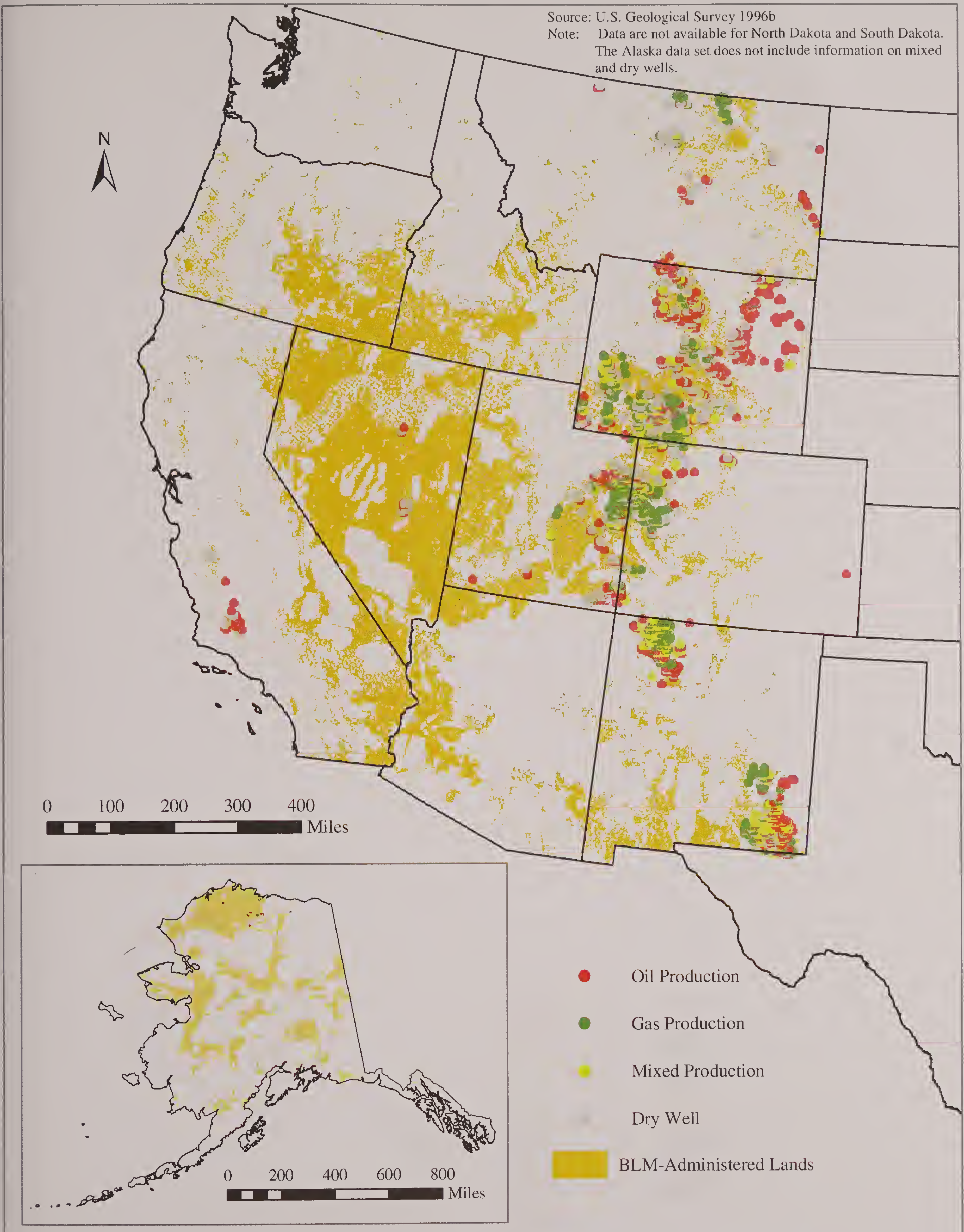
During FYs 2002 to 2005, 49 USDI personnel were injured conducting fire operations. During 2005, wildland fires resulted in the loss of 240 primary residences and 750 total structures on lands near BLM- or Forest Service-administered lands (USDI BLM 2006c).



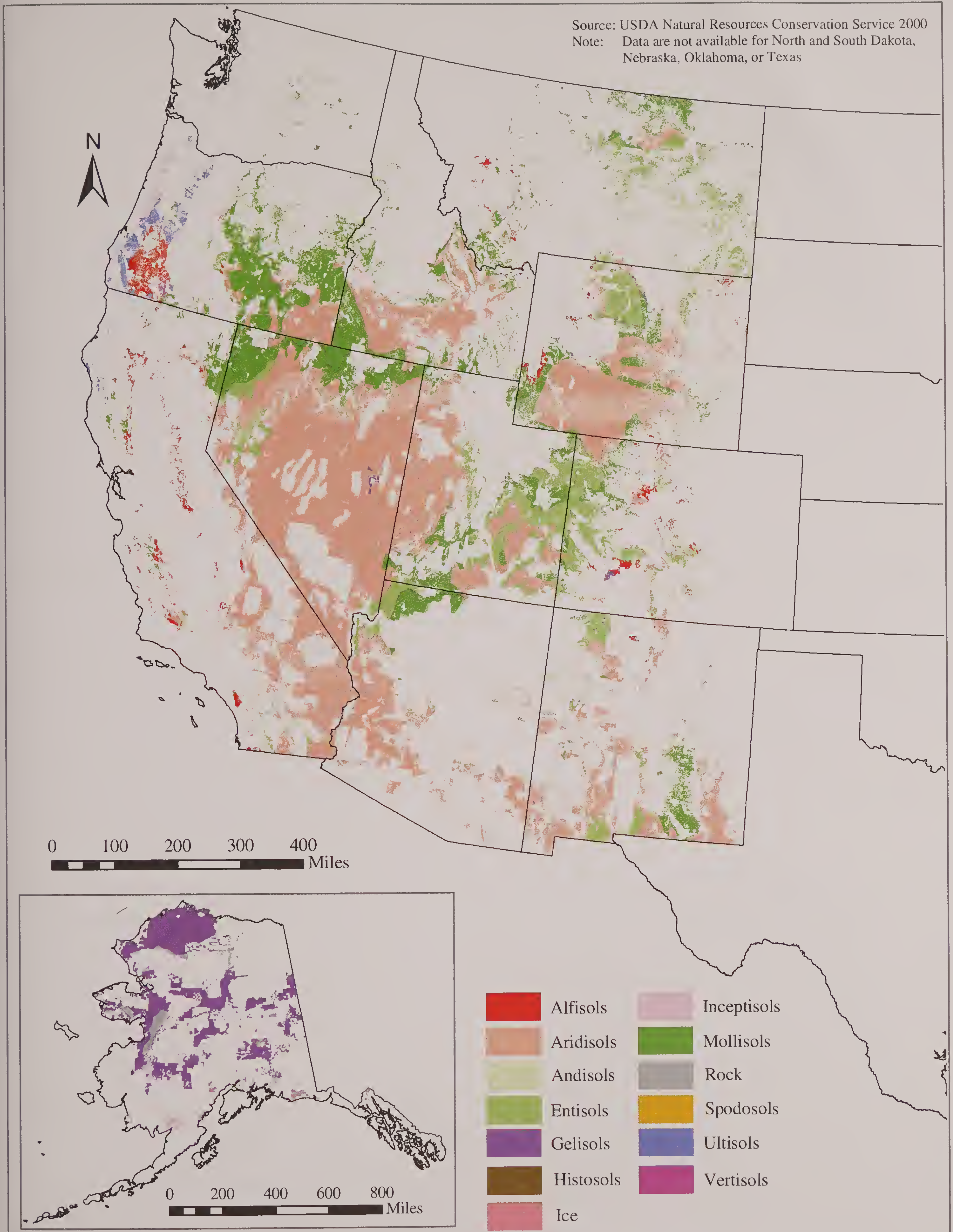
Map 3-1
Ecoregion Divisions



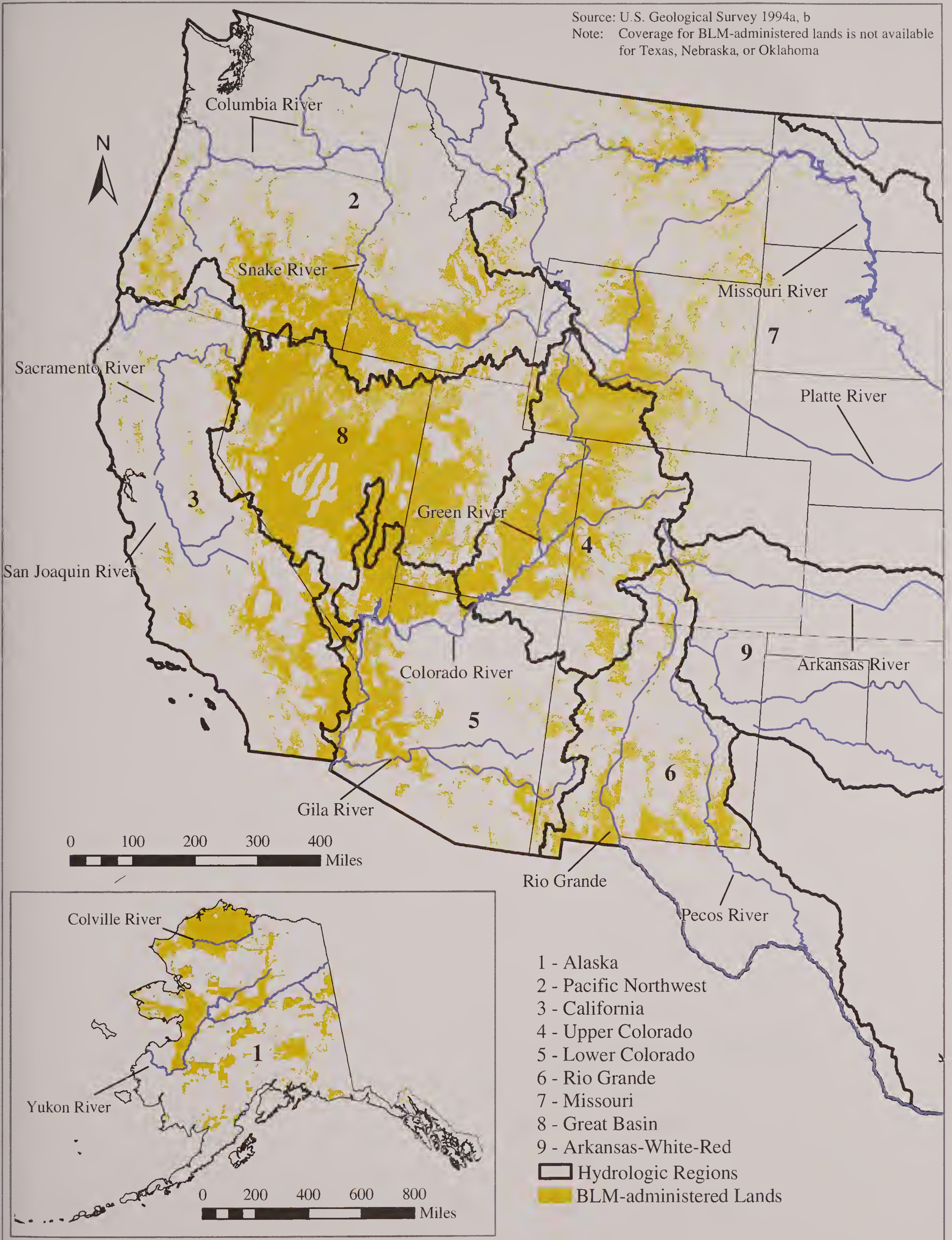
Map 3-2
Class I Areas



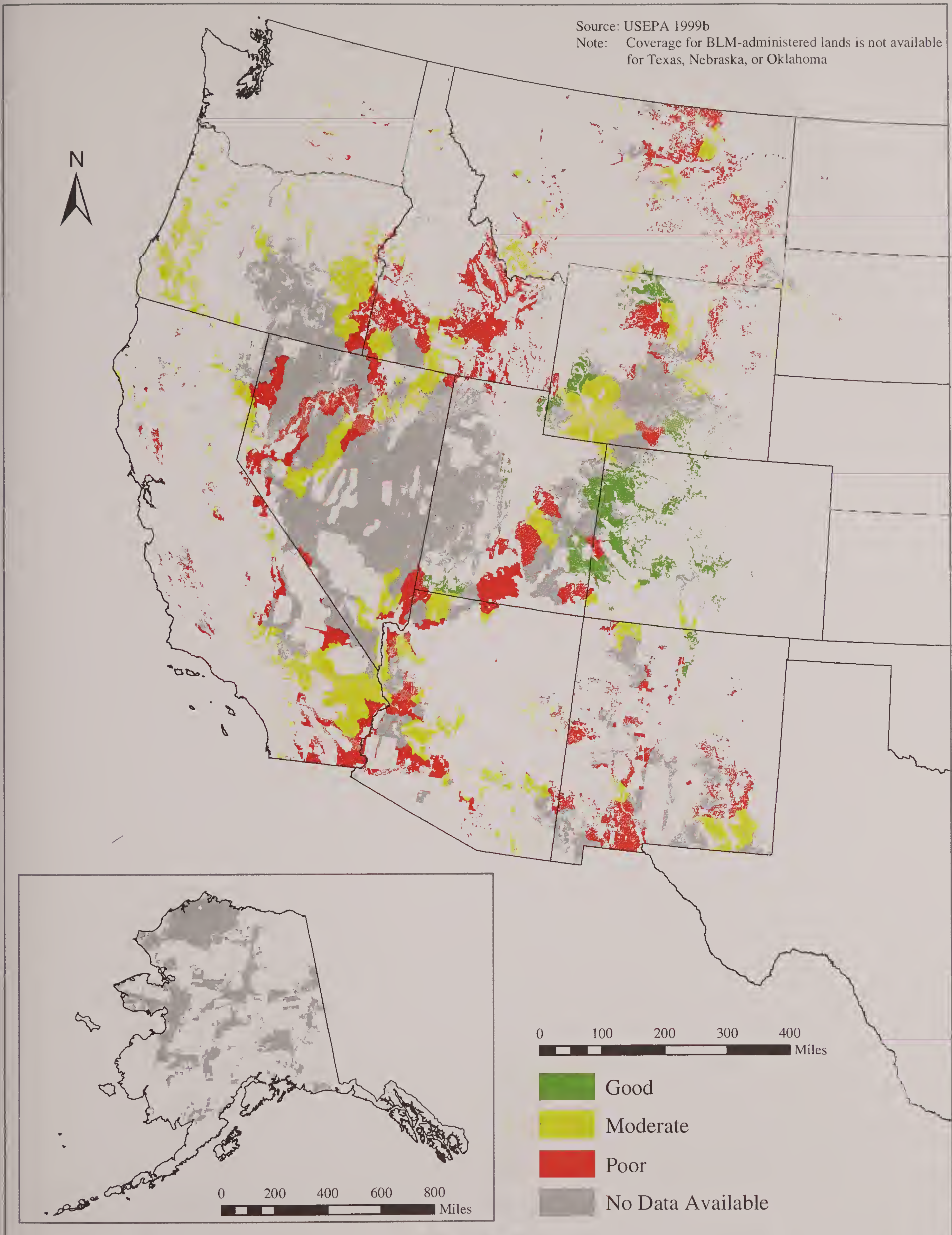
Map 3-3
Oil and Gas Wells on Public Lands



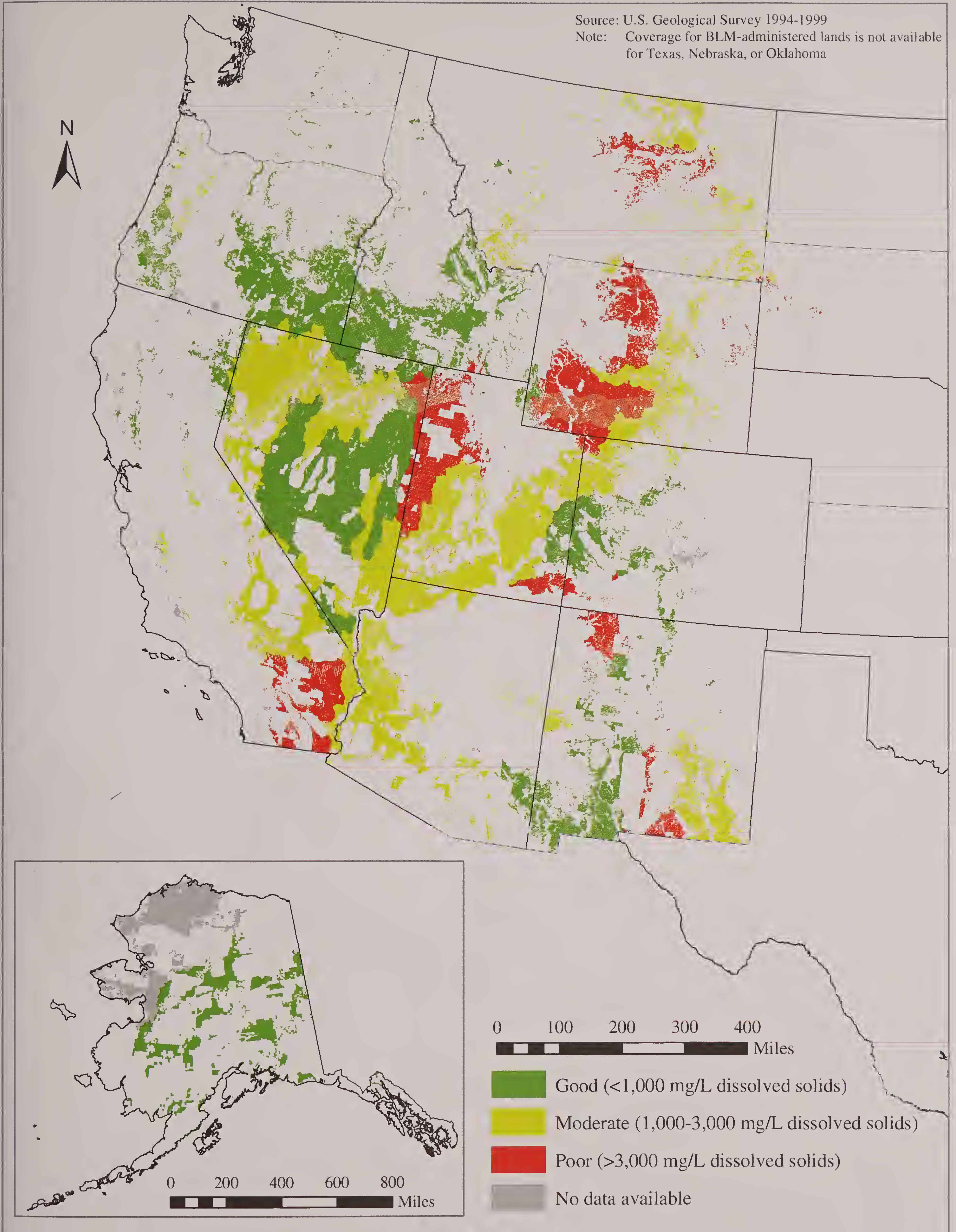
Map 3-4
Soil Orders on Public Lands



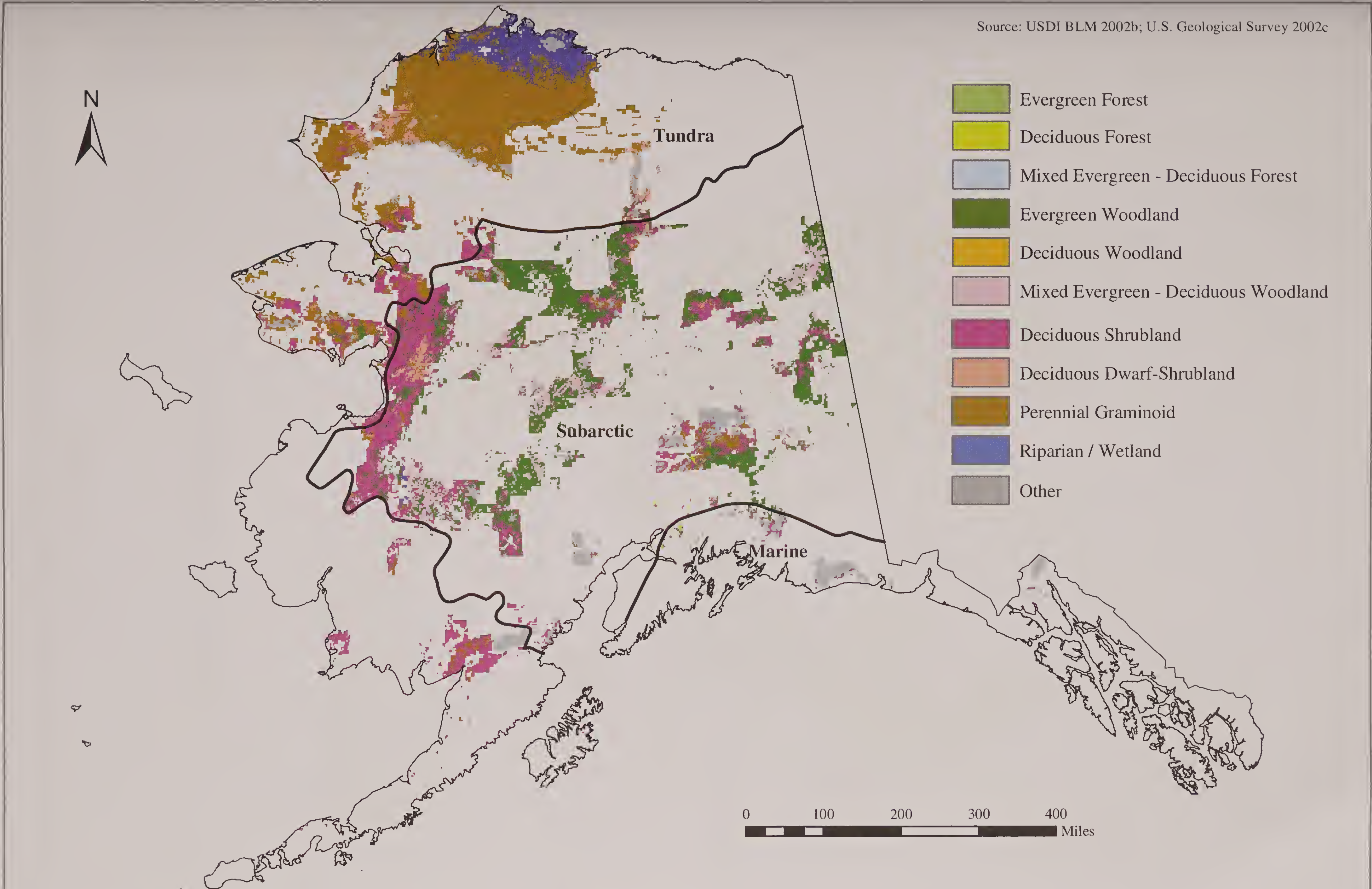
Map 3-5
Hydrologic Regions



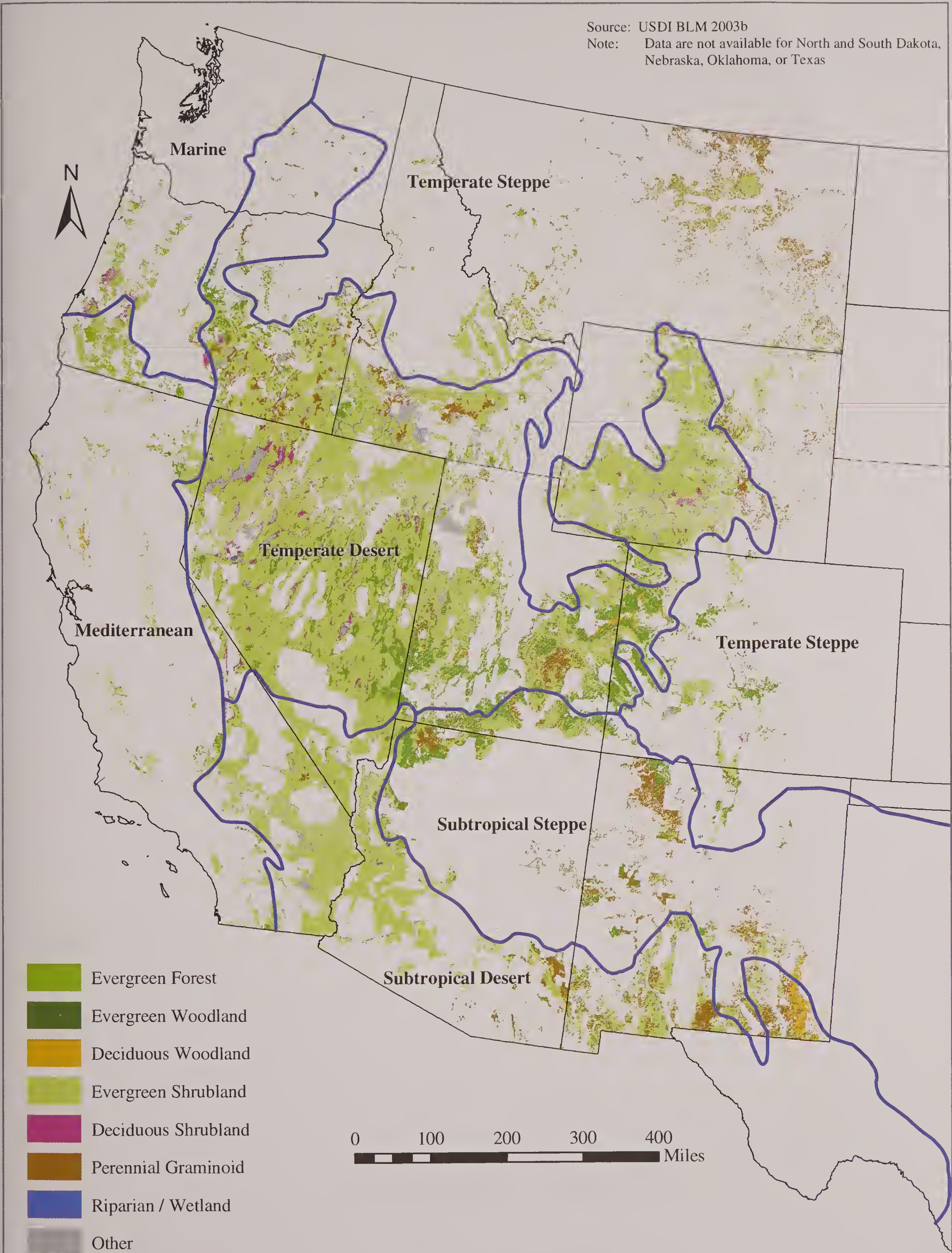
Map 3-6
Watershed Surface Water Quality on Public Lands



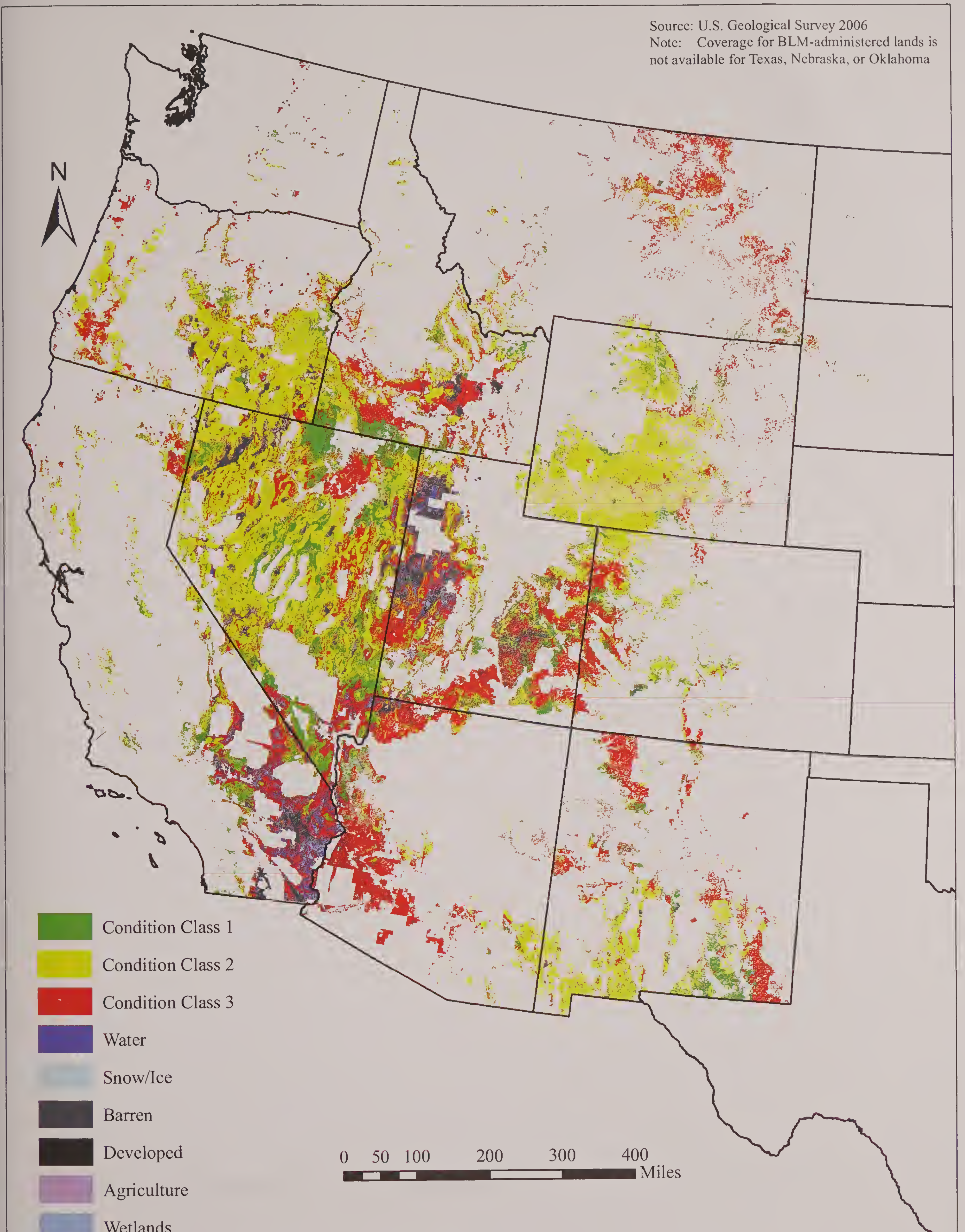
Map 3-7
General Groundwater Quality on Public Lands



Map 3-8
Vegetation Types and Ecoregions on Public Lands in Alaska

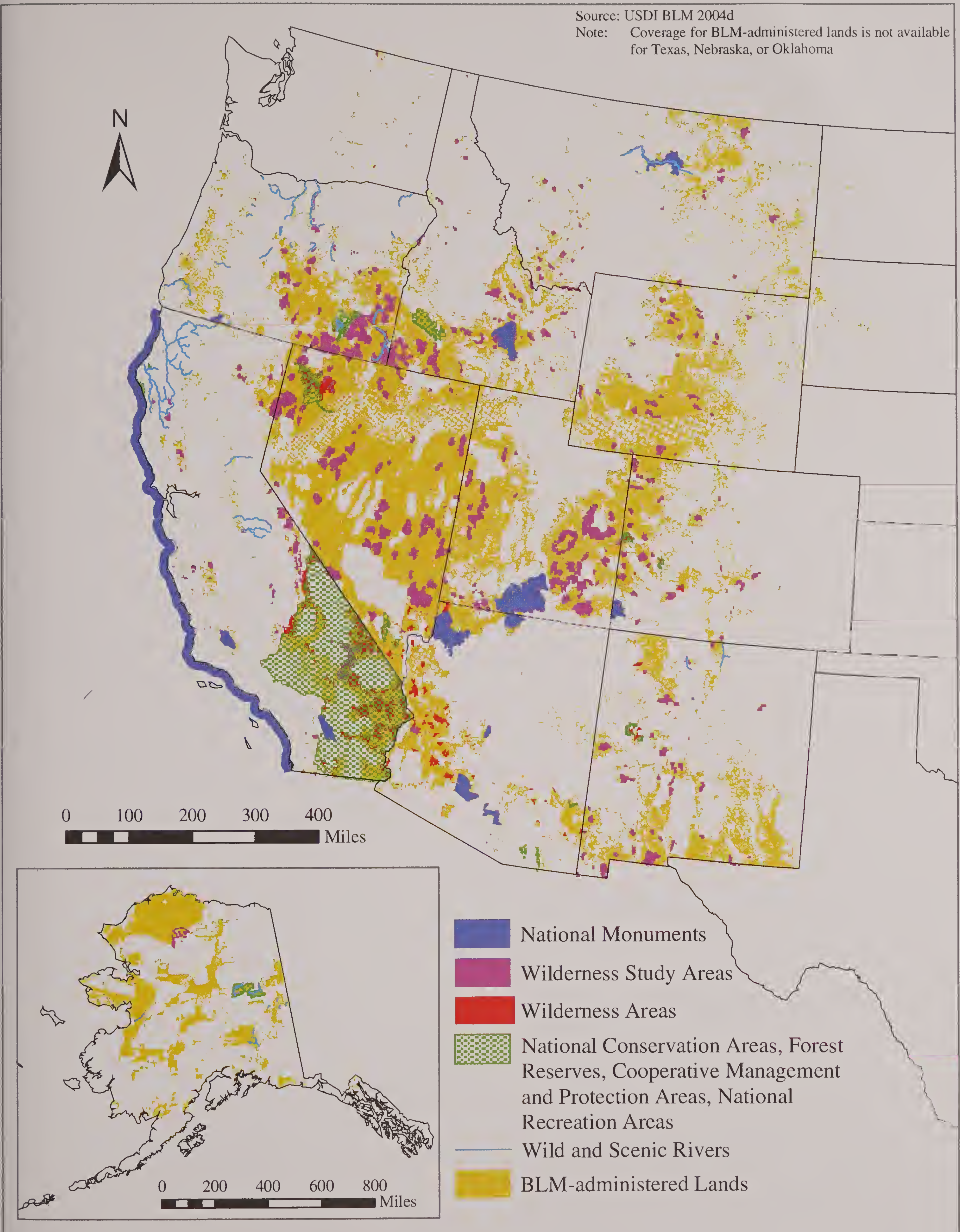


Map 3-9
Vegetation Types and Ecoregions on Public Lands in the Western U.S.



Map 3-10
Fire Regime Condition Classes on Public Lands

Map 3-11
Native Areas of Western North America



Map 3-12
National Landscape Conservation System Areas

CHAPTER 4

EFFECTS OF VEGETATION TREATMENTS

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CHAPTER 4

EFFECTS OF VEGETATION TREATMENTS

Introduction

This chapter examines how vegetation treatment activities could affect natural, cultural, and socioeconomic resources on public lands. The focus of the effects assessment is on non-herbicide treatment methods. A summary of effects associated with the use of herbicides has also been included based on information provided in the *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States PEIS* (USDI BLM 2007a). Within each resource area, applicable direct and indirect effects are evaluated. Cumulative effects, unavoidable adverse effects, and those resource commitments that cannot be reversed or are lost are identified for all treatment activities in the PEIS. These effects are defined as follows:

- Direct effects – Those effects that occur at the same time and in the same general location as the activity causing the effects.
- Indirect effects – Those effects that occur at a different time or in a different location than the activity to which the effects are related.
- Cumulative effects – Those effects that result from the incremental impact of the action when it is added to other past, present, and reasonably foreseeable future actions (see Chapter 4 of PEIS).
- Unavoidable adverse commitments – Those effects that could occur as a result of implementing any of the action alternatives. Some of these effects would be short term, while others could be long term (see Chapter 4 of PEIS).
- Irreversible commitments – Those commitments that cannot be reversed, except perhaps in the extreme long term (see Chapter 4 of PEIS).
- Irretrievable commitments – Those commitments that are lost for a period of time (see Chapter 4 of PEIS).

This chapter should be read together with Chapter 2 (Vegetation Treatment Programs, Policies and Methods), which explains the methods the BLM typically uses for treating vegetation, and Chapter 3 (Public Land Resources), which describes the important resources and their occurrence and condition on public lands. The descriptions of environmental effects in this chapter build upon and relate to information presented in these earlier chapters to identify the types and distribution of resources that could be affected by vegetation treatments and how these effects might occur.

This report addresses large, regional-scale trends and issues that require integrated management across broad landscapes. It also addresses regional-scale trends and changes in the social and economic needs of people. This report does not identify site-specific effects, in part because of the level of specificity in broad-scale management direction, and because site-specific information is not essential for determining broad-scale management direction. As discussed in Chapter 1, Purpose of the Environmental Report, site-specific issues would be addressed through subsequent NEPA analysis for resource management and other land use, activity, or project plans prepared at the state, district, or field office level.

The description of effects assumes that SOPs would be followed by the BLM to ensure that risks to human health and the environment from different vegetation treatments methods were kept to a minimum (see Table 2-5).

General SOPs that would be followed for all resources include the following:

Fire Use

- Prepare fire management plans.
- Use trained personnel with adequate equipment.
- Minimize frequent burning in arid environments.
- Minimize burning herbicide-treated vegetation for at least 6 months.

Mechanical Treatments

- Ensure that power cutting tools have approved spark arresters.
- Ensure that crews have proper fire-suppression tools during the fire season.
- Wash vehicles and equipment before leaving weed infested areas to avoid infecting weed-free areas.
- Keep equipment in good operating condition.

Manual Treatments

- Ensure that crews have proper fire-suppression tools during fire season.
- Minimize soil disturbance, which may encourage new weeds to develop.

Biological Treatments

- Use only biological control agents that have been tested and approved to ensure they are host specific.
- If using domestic animals, select sites with weeds that are palatable and non-toxic to the animals.
- Manage the intensity and duration of containment by domestic animals to minimize overutilization of desirable plant species.
- Utilize domestic animals to contain the target species in the treatment areas prior to weed seed set. Or if seed set has occurred, do not move the domestic animals to uninfested areas for a period of 7 days.

Herbicide Treatments

- Prepare a spill contingency plan in advance of treatment.
- Select herbicides that are the least dangerous to environment while providing the desired results.
- Minimize the size of the application area, where feasible.
- Use the least amount of herbicide necessary to achieve the desired result.
- Follow the product label for use and storage.
- Have licensed applicators apply herbicides.
- Keep records of each application, including the active ingredient, formulation, application rate, date, time, and location.
- Dispose of unwanted herbicides promptly and correctly.

Additional SOPs are presented, by resource, under the appropriate resource subheadings, as well as in Table 2-5.

This report assumes that the BLM would comply with federal, state, tribal, and local regulations that govern activities on public lands. In addition, mitigation measures have been identified for most resources to further reduce effects associated with non-herbicide and herbicide vegetation treatments.

Subsequent Analysis before Projects are Initiated

At the national level, this PER and the PEIS identify broad management direction in context with resource issues of national interest. This PER assumes that vegetation treatments would occur on approximately 6 million acres annually, that treatments would focus on areas with high levels of hazardous fuels and unwanted vegetation, that allowable land uses would comply with the intent of Congress as stated in the FLPMA (43 U.S.C. 1701 *et seq.)*, and that future land uses would be similar to those that currently occur on public lands. Modifications to existing land uses could occur at a lower level, primarily the field office level, based on information in the PER and analysis in the PEIS.

Before site-specific actions are implemented and an irreversible commitment of resources made, information essential to those fine-scale decisions will be obtained by the local land managers. Localized data and information will be used to supplement or refine regional-level data and identify methods and procedures best suited to local conditions. Further NEPA analysis

may be necessary to address site-specific conditions and processes. For example, mitigation measures identified in the PEIS would be appropriate under the wide range of conditions that must be considered at the programmatic level. However, by considering more site-specific parameters, such as soil and vegetation type and amount of rainfall, the BLM may be able to implement less restrictive mitigation measures while still ensuring adequate protection of the resource. This subsequent NEPA analysis will be used to bridge the gap between broad-scale direction and site-specific decisions. This "step-down" analysis process is described in Chapter 1 of the PEIS and shown in Figure 1-1 of that document.

Program Goals by Ecoregion

The goals of chemical vegetation treatments, by ecoregion, are discussed below. Because chemical treatments are not planned for the Tundra and Subarctic ecoregions, they have been excluded from this discussion.

Temperate Desert Ecoregion

Over 70% of herbicide treatments would occur on public land in the Temperate Desert Ecoregion. Most of these treatments would be used to meet vegetation and integrated weed management (IWM) objectives (33% of treatments), reduce hazardous fuels (25%), conduct ES and BAR activities (19%), and improve rangeland health (12%). Improvements of wildlife habitat and watershed health are objectives of lesser importance (6% and 5% of treatments, respectively) in this ecoregion.

Temperate Steppe Ecoregion

In the Temperate Steppe Ecoregion, most herbicide treatments would be conducted to meet IVM and/or IWM objectives (62% of treatments). Other important objectives include hazardous fuels reduction (25%) and improvement of rangeland health (11%).

Subtropical Steppe Ecoregion

On public lands in the Subtropical Steppe Ecoregion, herbicide treatments would be used to improve habitat (38% of treatments), improve rangeland health (21%), reduce hazardous fuels (17%), and meet IVM and/or IWM objectives (11%).

Mediterranean Ecoregion

In the Mediterranean Ecoregion, chemical treatments would be conducted primarily to improve forest health (35% of treatments), and to meet maintenance-related (28%) and IVM and/or IWM (20%) objectives. Improvement of rangeland health (9%) and recreation areas (6%) would also be important objectives.

Marine Ecoregion

On BLM lands in the Marine Ecoregion, the majority of herbicide treatments would be conducted to meet IVM and/or IWM (69%) and maintenance-related (22%) objectives. Some less important treatment objectives include maintaining ROW (3%), improving forest health (3%), and improving habitat for native vegetation (3%).

Land Use

As discussed in Chapter 1, several federal laws, regulations, and policies guide BLM management activities on public lands. These include the *Federal Land Policy and Management Act of 1976* that directs the BLM to manage public lands "in a manner that will protect the quality of scientific, scenic, historic, ecological, environmental, air and atmospheric, water resources and archeological values" and to develop resource management plans consistent with those of state and local governments to the extent that BLM programs also comply with federal laws and regulations. Management actions on public lands are guided by land use plans. Land use plan decisions establish goals and objectives for resource management, the measures needed to achieve these goals and objectives, and parameters for using public lands (USDI BLM 2000c). The *Taylor Grazing Act of 1934* introduced federal protection and management of public lands by regulating grazing on public lands. The *Oregon and California Grant Lands Act of 1937* provides for the management of the revested Oregon and California and reconveyed Coos Bay Wagon Road grant lands for permanent forest production under the principle of sustained yield and for leasing of lands for grazing.

As discussed in Chapter 1, NEPA analysis occurs at several levels, which allows the BLM to tailor decisions to specific needs and circumstances. The broadest level, which this PER represents, is a national-level programmatic study. This level of study contains broad regional descriptions of resources, provides a broad assessment of environmental effects, including

cumulative effects (see PEIS), focuses on general policies, and provides Bureau-wide direction on herbicide use and other available tools for vegetation management. Additionally, it provides baseline information supporting an umbrella ESA Section 7 consultation for the broad range of activities described in the PER and PEIS.

Air Quality

Air quality would be affected by vegetation treatment activities, primarily smoke from prescribed fire, dust and combustion engine exhaust from mechanical, manual, and biological treatments, and from volatized chemicals associated with herbicide treatments. Except for smoke, effects would be small in scale, temporary, and quickly dispersed throughout the treatment area. Provided SOPs are followed (Table 2-5), and site-specific plans developed and reviewed before a treatment activity occurs, federal, state, and local air quality regulations would not be violated.

Potential air quality effects are assessed before project implementation. The BLM develops land use plans to establish and define resource management objectives for a particular area (USDI BLM 1998). Site-specific plans are reviewed for compliance with applicable federal, state, and local laws and policies. Guidance given in BLM manuals and handbooks is followed in order to minimize potential effects to air quality. Additional mitigation may be incorporated into project proposals to further reduce predicted effects.

The following sections discuss the general types of effects to air quality associated with each treatment method, followed by a discussion of air emission effects predicted to occur in the western U.S. using different vegetation treatment activities.

Scoping Comments and Other Issues Evaluated in Assessment

Respondents suggested that recent historic and projected emissions from prescribed fire and wildland fire should be considered when estimating resource benefits.

Resource Program Goals

The Soil, Water, and Air Management Program is responsible for assisting local field offices in 1) assessing air quality effects and ensuring that air quality conformance requirements are met when implementing federal land management decisions; 2) working proactively with applicable state and local air regulatory agencies to simplify and facilitate future conformity evaluations; and 3) participating in the regional analysis of air quality effects from fire use and other activities on public lands.

Standard Operating Procedures

Practices to Minimize Smoke Production

There are two general strategies for reducing smoke emissions: avoidance (e.g., fire prevention and suppression) and fuel modification. The latter includes techniques for altering either the existing fuel loading, structure, or both. Techniques for fuel modification include utilization (such as thinning or final harvest), mechanical treatment (piling, lopping and scattering, and crushing), and prescribed fire. These strategies can benefit air quality over both the short and long term.

Prescribed fire emissions can be reduced by 1) having clear smoke management objectives; 2) evaluating weather conditions, including wind speed and atmospheric stability, to predict the effects of fires and impacts from smoke; 3) burning when conditions favor rapid combustion and dispersion; 4) burning under favorable moisture conditions; 5) using backfires when applicable; 6) burning small vegetation blocks when appropriate; 7) managing smoke to prevent air quality violations and minimize impacts to smoke-sensitive areas; and 8) coordinating with regional and local air pollution and fire control officials, and obtaining all applicable smoke management permits, to ensure that burn plans comply with federal, state, and local regulations.

Practices to Minimize Emissions Associated with Manual and Mechanical Methods

Practices to minimize emissions associated with the use of manual and mechanical treatment methods include maintaining equipment in optimal working order, conducting treatment activities during the wetter seasons (to minimize fugitive dust production), using heavy equipment under adequate soil moisture conditions to minimize soil erosion, minimizing vehicle speeds on unpaved roads, and minimizing dust impacts to the extent practical. These practices can improve air quality over both the short and long term.

Practices to Minimize Herbicide Treatment Emissions

The BLM has developed several management practices to minimize the potential adverse effects of herbicide use on air quality. These management practices are based on direction in BLM air quality, chemical pest control, and weed management manuals (e.g., manuals 7000 and 9011) and handbooks (e.g., H-9011-1; USDI BLM 1988c). Most of this guidance is related to the effects of spray drift or other forms of wind transport of herbicides. For example, guidance on spray particle size, wind velocity and direction, height of spray boom, herbicide formulation, and drift control spray systems is presented with respect to their effects on spray drift and non-target species. The following SOPs have been developed to guide herbicide applications to minimize the short-term effects on air quality:

- Consider the effects of wind, humidity, temperature inversions, and heavy rainfall on herbicide effectiveness and risks.
- Apply herbicides in favorable weather conditions to minimize drift. For example, do not treat when winds exceed 10 mph (6 mph for aerial applications) or rainfall is imminent.
- Use drift reduction agents, as appropriate, to reduce the drift hazard.
- Select proper application equipment (e.g., spray equipment that produces 200- to 800-micron diameter droplets [spray droplets of 100 microns and less are most prone to drift]).
- Select proper application methods, such as setting maximum spray heights and using appropriate buffer distances between spray sites and non-target resources.

The description of potential effects to air quality assumes that guidance provided in BLM manuals, handbooks, and SOPs would be followed during herbicide treatment activities.

Adverse Effects of Treatments

Effects of Fire Treatments

This section summarizes information on the effects of fire on air quality. Other sources of information that should be consulted before planning a burn include: *Effects of Fire on Air: A State-of-knowledge Review* (Sandberg et al. 1979); *Prescribed Fire Smoke Management Guide* (Prescribed Fire and Fire Effects Working Team 1985); *National Strategic Plan: Modeling and Data Systems for Wildland Fire and Air Quality* (Sandberg et al. 1999); *Smoke Management Guide for Prescribed and Wildland Fire* (Hardy et al. 2001); *Fire Effects Guide* (Fire Use Working Team 2001); *Development of Emissions Inventory Methods for Wildland Fire* (Battye and Battye 2002); and *Wildland Fire in Ecosystems: Effects of Fire on Air* (USDA Forest Service 2002b).

The most important atmospheric effect of both prescribed fire and wildfire is smoke. Prior to the 1930s, smoke was a common feature of the western landscape in summer (Barrett and Arno 1982). Since then, land managers have focused on controlling wildfires, and smoke has become increasingly viewed by the public and policymakers as undesirable and often avoidable (Schaaf 1994). In addition to affecting the visual characteristics of an area, smoke can also affect the health of humans, plants, and animals that come into contact with smoke.

The total volume of smoke produced from a fire depends primarily on the amount of fuel consumed and the temperature of the burn. Factors influencing smoke production include fuel type, fire behavior, fuel moisture, particle size, particle arrangement, and fuel weight per unit area (Tables 4-1 and 4-2). In general, emissions per unit of fuel burned are greater at higher fuel moistures and lower temperatures. Fuel beds composed of small particles packed tightly together tend to burn more slowly and produce more smoke than larger particles less tightly packed. Finally, the more fuel available to burn, the greater the smoke production (Prescribed Fire and Fire Effects Working Team 1985, USEPA 1996).

A number of air pollutants are found in smoke emissions, including CO_2, CO, PM_{10} and $PM_{2.5}$, and VOCs. Carbon dioxide and water vapor make up the majority of emissions (about 90%) from prescribed fire and wildfire (Prescribed Fire and Fire Effects Working Team 1985). Lesser quantities of CO, PM_{10}, $PM_{2.5}$, and VOCs are also produced.

Carbon dioxide makes up more than 70% of the total mass emitted from wildfires. This amounts to 2,000 to 3,500 pounds of CO_2 per ton of fuel consumed, depending on the fuel's combustion efficiency (Schaaf 1994). Carbon dioxide emissions from fire have no direct health or visibility effects. It is not generally considered an air pollutant, and therefore is not regulated. But it is a so-called "greenhouse gas" and

figures prominently in global climate change assessments.

Carbon monoxide is the most abundant air pollutant emitted during burning, representing nearly 6% of the total mass emitted. This amounts to approximately 20 to 500 pounds of CO per ton of fuel consumed. Carbon monoxide has no effect on visibility, but can present a direct health hazard to fire line workers. Concentrations as high as 200 ppm have been recorded near flames, well above the NAAQS of 35 ppm for a 1-hour averaging period. Because CO dilutes rapidly to levels below the NAAQS, it presents minimal risk to community air quality around prescribed burns.

Particulate matter is the most important air pollutant emitted from fire because of its far-reaching effects. Particulate matter represents approximately 2% of the total mass emitted from wildfires. This amounts to approximately 20 to 180 pounds of PM emitted per ton of fuel consumed. The particles emitted from wildfires vary in size and composition, depending on the intensity of the fire and the characteristics of the fuel bed.

From an air quality standpoint, the two most important size categories of particulate matter are $PM_{2.5}$ and PM_{10}. Fine particles are readily transported by wind, and can affect community air quality at long distances from fires. The Yellowstone National Park wildfires in 1988 affected communities in three states, and concentrations of PM_{10} measured in communities near the fires exceeded the applicable NAAQS (USDA Forest Service 2002b).

Volatile organic compounds are a diverse group of potentially toxic air pollutants containing hydrogen, carbon, and sometimes oxygen and other trace elements. Together, VOCs represent nearly 1% of the total mass emitted in fires. Approximately 20 pounds of VOCs are produced for each ton of fuel consumed (Schaaf 1994). The primary risk from VOCs is adverse effects to human health.

Regional Air Quality Effects. The quantity of emissions from wildfires, and thus the effects on air quality from smoke, varies from fire to fire, depending on several factors. A fire's size, duration, intensity, fuel type, surface fuel loading by size class, and fuel moisture content all affect its total fuel consumption and emission characteristics. The fire's intensity and distance from receptors, as well as current meteorological conditions such as wind speed and atmospheric stability, affect the concentrations that arrive at downwind receptors. Regionally, air quality risks are roughly proportional to the total annual emissions from wildfires. The greater the emissions, the greater the expected effects on human health and visibility.

Other Air Emissions Associated with Fire Use. In addition to pollutants generated by prescribed fire, minor amounts of pollutants would be generated during travel to and from the treatment site by fire crews, and from mechanical treatments (e.g., bulldozing) associated with site preparation before burning (ENSR 2005a). These pollutants would include $PM_{2.5}$, PM_{10}, CO, NO_2, SO_2, and VOCs associated with vehicle exhaust, as well as fugitive dust.

Mechanical, manual, and herbicide treatments conducted prior to, or in support of, prescribed fire can indirectly influence the amount of pollutants generated through removal of fuels or change in the fuel characteristics (Fire Use Working Team 2001). Removal of fuels would reduce the amount of air pollutants produced during burning. Crushing fuels increases the fuel bulk density and can make the rate of burning slower. Lopping, windrowing, and chaining can alter the distribution of fuels and influence fire behavior and smoke production. The use of herbicides can kill vegetation and result in a large amount of standing dead vegetation and amount of fuel available to burn.

Effects of Mechanical and Manual Treatments

Particulate matter associated with operation and use of mechanical and hand-held equipment, as well as driving on unpaved roads to and from the treatment site, would be the primary pollutant associated with mechanical and manual treatments. Power equipment and machinery exhaust would emit CO, SO_2, NO_2, VOCs, and other minor pollutants. However, emissions would generally be small, localized, and temporary.

Effects of Biological Treatments

Biological control organisms would have few direct effects on air quality. Grazing animals would generate odors and dust, but these emissions would be minor, localized, and short term in duration. Emissions associated with vehicle exhaust and dust would occur during transport to treatment sites; these emissions would also be minor, localized, and short term in duration. Practices to minimize transportation emissions would be the same as those identified for mechanical and manual treatments. Odors and dust associated with grazing animals could be reduced by limiting the density of animals confined to an area.

TABLE 4-1
Emission Factors for Particulate Matter as a Function of Fire Behavior

General Fuel Type	Fire Behavior	PM_{10} Emission Factor (pounds/ton of fuel burned)
Grass	Flaming dominates	15
Understory Vegetation Litter	Flaming with light smoldering Flaming with moderate smoldering Flaming with moderate smoldering	25 50 75
Broadcast Slash	Flaming dominates Flaming with smoldering component	20 40
Piled and Windrowed Slash	Flaming dominates Flaming with moderate smoldering Flaming with heavy smoldering	25 50 75
Brush fuels	Flaming dominates Flaming with moderate smoldering	25 50
All fuels	Burning where smoldering dominates	150
Source: Prescribed Fire and Fire Effects Working Team (1985).		

Effects of Chemical Treatments

The effects of herbicide use on air quality originate primarily from ground vehicle (truck, ATV, and boat) and aircraft (plane and helicopter) exhaust emissions, as well as fugitive dust (dust created by vehicle travel on unpaved roads) resulting from herbicide transport and application. In addition, spray drift (movement of herbicide in the air to unintended locations) and volatilization (the evaporation of liquid to gas) of applied herbicides temporarily results in herbicide

particles in the air, which can be inhaled and deposited on skin or plant surfaces, with the potential to affect humans, wildlife, and non-target plants. In addition, herbicide particles could be transported long distances from the target location, depending on weather conditions and the herbicide application method. A more detailed assessment of effects associated with the use of herbicides is given in the PEIS.

Air Quality Regulations

Smoke from prescribed fires, and to lesser extent, air pollutants from other vegetation treatment methods, are regulated under the Clean Air Act. As discussed in Chapter 3, states are required to achieve NAAQS through a state implementation plan, approved by the USEPA. Some state regulations pertaining to air quality are administered by more than one state agency, or by local or regional agencies. Thus, the BLM often must coordinate with more than one local, state, or federal agency to ensure that its actions comply with all procedural and substantive requirements.

An overview of state and local laws pertaining to controlled burning is provided in *Prescribed Fire Smoke Management Guide* (Prescribed Fire and Fire Effects Working Team 1985). In addition, a survey of smoke management programs in the western U.S. was conducted for the BLM (Core Environmental Consulting 1998) and for the Western Governors' Association (Battye et al. 2001). In 2002 and 2003, a similar survey was conducted for the PER (ENSR 2003). A total of 121 agencies were contacted in 2002 and 2003, including several tribal governments. The results of the survey can be found on the CD that accompanies the PEIS and on the BLM website at: http://www.blm.gov.

In general, most states have some permitting requirements to regulate smoke from prescribed burns. A number of local municipalities also have jurisdiction in issuing burn permits and enforcing burn permit requirements. Authorization typically depends on the scale of the proposed burn. For a farmer or resident seeking to burn dead vegetation on his or her own property, only a simple burn permit from the local health and fire departments may be required. For prescribed burns anticipated by the BLM, most regulatory agencies require detailed burn permits and often the submission of a detailed smoke management plan (SMP).

Most western state air quality agencies have an operating agreement or memorandum of understanding in place outlining their shared responsibilities and

TABLE 4-2
Emission Factors for Prescribed Burning by Fuel Type (pounds/ton of fuel burned)

Fuel Type	$PM_{2.5}$	PM_{10}	CO
Broadcast-burned slash			
Douglas-fir/western hemlock	21.8	23.2	311
Hardwoods	22.4	25.0	255
Ponderosa/lodgepole pine	21.9	25.0	177
Mixed conifer	18.8	20.6	201
Juniper	18.8	20.4	164
Pile-and-burn slash			
Tractor-piled	10.8	12.4	154
Crane-piled	23.4	25.6	186
Average piles	17.2	19.0	170
Broadcast-burned brush			
Sagebrush	26.8	30.0	206
Chaparral	17.4	20.2	154

Source: Battye and Battye (2002).

expectations with neighboring agencies or jurisdictions regarding SMP requirements. Most SMPs, at the minimum, also require that burn-related personnel be properly trained in a specialized course dedicated to smoke and prescribed fire management techniques. Some states also offer computer modeling training, allowing potential burners to analyze and prepare burning prescriptions that minimize air pollutant emissions.

Another necessary element of a prescribed burn is the evaluation of smoke dispersion conditions. Conditions are typically evaluated by obtaining meteorological information for the burn day, as well as forecasts for the duration of the burn. The main components usually forecast are wind speed, wind direction, ceiling level, mixing depth, atmospheric stability, and presence of inversions. In addition, daytime and nighttime wind paths and down-drainage flow of smoke may be required for areas downwind of the burn site. Also, local dispersion conditions may need to be verified by land managers by utilizing one of the following measurement techniques: release of a pilot balloon at the burn site; establishment of area-representative or actual burn site remote automated weather stations (or the equivalent) to obtain real-time data; or smoke plume measurements using formats supplied by the permitting agency.

Other Treatment Emissions

State and local air quality regulatory agencies do not typically have specific regulations for manual, mechanical, biological, or herbicide treatment methods.

Air Quality Modeling to Assess Effects from BLM Vegetation Treatment Methods

Compliance with National Ambient Air Quality Standards

To estimate the potential effects of vegetation treatment activities on local and regional air quality, example emission scenarios for each of the five treatment methods at six representative locations (Fairbanks, Alaska; Tucson, Arizona; Glasgow, Montana; Winnemucca, Nevada; Medford, Oregon; and Lander, Wyoming) were analyzed using the California Puff (CALPUFF) "lite" air pollutant dispersion model to predict concentrations of total suspended particles (TSP), PM_{10}, and $PM_{2.5}$ (ENSR 2005a). Predicted concentrations were then added to a representative rural background concentration for comparison with NAAQS in order to determine the potential significance of the effect.

As shown in Table 4-3, predicted short-term and annual particulate matter effects at each of the six example locations were extremely small (< 0.1 microgram per cubic meter [$\mu g/m^3$]) for all treatment methods other than prescribed fire. Even for prescribed fire, short-term and annual emissions were less than 1.3 $\mu g/m^3$ for all locations, except for Fairbanks, Alaska, where 24-hour TSP and PM_{10} effects were predicted to be as high as 38 $\mu g/m^3$ (34 $\mu g/m^3$ 24-hour $PM_{2.5}$). Assuming a rural background 24-hour $PM_{2.5}$ concentration of 30 $\mu g/m^3$, the total concentration of 64 $\mu g/m^3$ would approach the applicable $PM_{2.5}$ NAAQS of 65 $\mu g/m^3$. In all instances, particulate matter emissions due to the five treatment methods would not exceed the applicable NAAQS at any of the six locations, based on the assumptions of the analyses (ENSR 2005a).

Annual Emissions Inventory

Annual emissions were estimated for each treatment method for the following pollutants: CO, CO_2, TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, Pb, and VOCs (Table 4-4; ENSR 2005b.) The emission estimates are directly dependent on the number of acres treated, and thus the estimates given could vary depending on the actual number of acres treated by each method in each state.

Effects to Climate

The combustion of fossil-fuels and the burning of vegetation would release CO_2 (a so-called "greenhouse gas") to the atmosphere. However, a significant adverse

TABLE 4-3
Example Particulate Concentration (µg/m^3) Analysis by Treatment Method[1]

Location	Pollutant	Averaging Period	Treatment Method				
			Biological	Chemical	Manual	Mechanical	Prescribed Fire
Fairbanks, Alaska	TSP	24-hour	NA	NA	1.37E-01	4.14E-02	37.8
		Annual	NA	NA	1.12E-03	2.16E-04	4.36E-01
	PM_{10}	24-hour	NA	NA	1.37E-01	5.53E-02	37.8
		Annual	NA	NA	1.12E-03	2.88E-04	4.36E-01
	$PM_{2.5}$	24-hour	NA	NA	1.37E-01	3.08E-02	33.5
		Annual	NA	NA	1.12E-03	1.61E-04	3.87E-01
Tucson, Arizona	TSP	24-hour	1.76E-02	2.79E-04	7.31E-02	2.82E-02	2.81E-01
		Annual	4.94E-05	7.65E-07	2.01E-04	7.74E-05	1.14E-03
	PM_{10}	24-hour	4.31E-02	5.47E-04	7.31E-02	3.40E-02	2.81E-01
		Annual	1.21E-04	1.50E-06	2.01E-04	9.32E-05	1.14E-03
	$PM_{2.5}$	24-hour	6.02E-03	7.21E-05	7.31E-02	2.38E-02	2.56E-01
		Annual	1.68E-05	1.97E-07	2.01E-04	6.54E-05	1.04E-03
Glasgow, Montana	TSP	24-hour	2.96E-03	1.06E-04	5.65E-02	1.63E-02	3.58E-01
		Annual	9.06E-06	2.90E-07	1.72E-04	4.48E-05	1.14E-03
	PM_{10}	24-hour	5.90E-03	2.36E-04	5.80E-02	1.96E-02	3.58E-01
		Annual	1.74E-05	6.48E-07	1.76E-04	5.38E-05	1.14E-03
	$PM_{2.5}$	24-hour	7.78E-04	2.82E-05	5.60E-02	1.46E-02	3.03E-01
		Annual	2.29E-06	7.74E-08	1.70E-04	3.99E-05	9.63E-04
Winnemucca, Nevada	TSP	24-hour	7.65E-04	1.36E-04	3.27E-02	1.15E-02	3.19E-01
		Annual	5.80E-06	3.72E-07	9.00E-05	3.16E-05	8.85E-04
	PM_{10}	24-hour	1.86E-03	2.72E-04	3.32E-02	1.40E-02	3.19E-01
		Annual	1.42E-05	7.44E-07	9.16E-05	3.84E-05	8.86E-04
	$PM_{2.5}$	24-hour	2.59E-04	3.60E-05	3.25E-02	9.68E-03	2.91E-01
		Annual	1.98E-06	9.85E-08	8.92E-05	2.65E-05	8.08E-04
Medford, Oregon	TSP	24-hour	2.09E-02	3.75E-03	1.17E-01	4.89E-02	1.3
		Annual	6.31E-05	1.04E-05	3.52E-04	1.42E-04	6.18E-03
	PM_{10}	24-hour	5.65E-02	8.20E-03	1.18E-01	6.61E-02	1.3
		Annual	1.70E-04	2.28E-05	3.58E-04	1.92E-04	6.18E-03
	$PM_{2.5}$	24-hour	8.17E-03	1.14E-03	1.17E-01	3.90E-02	1.2
		Annual	2.46E-05	3.19E-06	3.50E-04	1.14E-04	5.76E-03
Lander, Wyoming	TSP	24-hour	3.57E-04	6.08E-05	2.82E-03	2.82E-03	2.44E-01
		Annual	1.85E-06	1.67E-07	1.36E-05	1.36E-05	6.77E-04
	PM_{10}	24-hour	9.35E-04	1.37E-04	3.29E-03	3.29E-03	2.44E-01
		Annual	4.84E-06	3.75E-07	1.70E-05	1.70E-05	6.77E-04
	$PM_{2.5}$	24-hour	1.24E-04	1.72E-05	2.51E-03	2.51E-03	2.21E-01
		Annual	6.43E-07	4.70E-08	1.17E-05	1.17E-05	6.13E-04

[1] Results based on use of CALPUFF model. Because of the variation in the number of treatment days for each method, the maximum 24-hour concentrations are listed in lieu of high, second high, or 98th percentile concentrations. Reporting the maximum concentrations also adds a level of conservatism to the modeling results.

NA = Not applicable.

Source: ENSR (2005a).

TABLE 4-4
Emissions Summary for Vegetation Treatments Activities (tons per year)

Pollutant	Prescribed Fire		Manual		Mechanical		Biological Control		Chemical	
	Cur[1]	Prop[2]	Cur	Prop	Cur	Prop	Cur	Prop	Cur	Prop
CO	824,030	2,001,936	829	2,662	109	416	9	12	24	62
CO_2	11,532,114	27,457,364	NA	NA	17,356	66,372	NA	NA	NA	NA
NO_x	21,757	61,325	4	11	468	1,791	1	1	3	7
TSP	101,881	221,044	29	94	26,392	73,032	3	5	7	19
PM_{10}	91,183	211,384	41	132	13,109	36,137	8	11	17	45
$PM_{2.5}$	77,102	186,406	25	80	5,279	14,599	1	2	2	6
Lead	141	365	0	0	0	0	0	0	0	0
SO_2	6,251	14,816	0	0	31	118	0	0	0	0
VOCs	48,545	113,475	139	447	38	147	1	1	2	5

[1] Cur = Current emissions based on current BLM vegetation treatment activities.
[2] Prop = Proposed emissions based on proposed BLM vegetation treatment activities.
NA = Not available.

effect on climate is not likely to be caused by BLM vegetation treatment activities.

Beneficial Effects of Treatments

Carefully planned and implemented prescribed fires result in less smoke effects to air quality than uncontrolled wildfires. The effects of smoke from prescribed fire, unlike those from wildfire, can be managed. Where effects of smoke from prescribed fire are of concern, fuel accumulations can be reduced through manual, mechanical, and chemical treatments prior to, or in place of, prescribed burning. Smoke effects can also be reduced by implementing burns when the wind is blowing away from smoke-sensitive areas and during good dispersion conditions (Hardy et al. 2001). Scheduling prescribed burns before new fuels accumulate can reduce the amount of emissions produced. Fire managers can also reduce the amount of area burned, increase the combustion efficiency of a burn, and increase the plume height in order to reduce smoke effects to air quality.

This PER does not analyze the long-term effects on air quality from implementing an aggressive vegetation treatment management program. However, an analysis of a similar vegetation management program in the Interior Columbia Basin showed that effects from wildfire on air quality and visibility could be significantly greater in magnitude than effects from prescribed burning (USDA Forest Service and USDI BLM 2000b). As discussed in this PER, and shown in the Interior Columbia Basin study, particulate matter emissions associated with prescribed burning and other treatment methods, when considered alone, should not cause widespread regional-scale exceedances of NAAQS. The same would not be true for wildfires. Thus, vegetation treatment actions that improve ecosystem health and reduce hazardous fuels buildup, thereby reducing the risk of wildfire, should provide long-term benefits to local and regional air quality.

Currently, about 645,000 acres are treated annually using prescribed fire and wildland fire for resource benefit, and 580,000 acres are treated using mechanical methods. Despite these efforts, a substantial amount (nearly 55 million acres) of public land is in Fire Regime Condition Class 3. Condition Class 3 lands have fire regimes that have been substantially altered from historical regimes; the risk of losing key ecosystem components to fire or other causes in these areas is high. The composition, structure, and diversity of vegetation, including fuels, have also been substantially altered in these areas. As a result, Condition Class 3 areas are especially susceptible to severe and intense wildland fires. As shown in Figure 3-10, these areas are often in close proximity to populated areas. Thus, wildfires in these areas have the potential to annoy and affect the health of large numbers of people.

The Forest Service and BLM modeled several scenarios to predict the long-term effect of treating vegetation to reduce hazardous fuels and improve ecosystem function on regional air quality and the condition of the land in the western U.S. (Hann et al. 2002). The model assumed that mechanical and hand cutting would be important treatment options in the WUI, in addition to use of fire, because air quality and other considerations

could limit the use of fire. This analysis predicted that air quality would generally improve as the number of acres treated annually increased, and that improvement in air quality would be most noticeable when treatments were targeted at high priority western U.S. WUI landscapes. Thus, increasing the number of acres treated annually from current levels (with about half of the treatments occurring in the WUI) should provide greater improvement in ecosystem function and air quality than is projected under current management.

Soil Resources

Vegetation treatments would potentially affect soils by altering their physical, chemical, and/or biological properties. Physical changes could include loss of soil through erosion or changes in soil structure, porosity, or organic matter content. Fire and other treatments would potentially alter nutrient availability and soil pH, and herbicide treatments would involve the addition of chemicals to the soil. Some vegetation treatments might also alter the abundance and types of soil organisms that contribute to overall soil quality, including mycorrhizae. Over the long term, treatments that remove invasive vegetation, reduce fuels, and restore native plants should enhance soil quality on public lands.

Scoping Comments and Other Issues Evaluated in Assessment

There was considerable concern that the BLM address herbicide runoff, overspray, and drift. It was noted that burning often degrades the soil. Other respondents felt that disturbances to cryptogamic crusts must be eliminated, and one respondent suggested that the practice of chaining be prohibited on public lands.

Resource Program Goals

The Soil, Water and Air Management program is responsible for activities involving soil on public lands. One important aspect of the project is reducing soil erosion on degraded lands in the Colorado River Basin, in order to reduce the transport of natural salts to the Colorado River and its tributaries. The program assists with vegetation treatments to improve watershed condition by restoring natural vegetation. As discussed below, treatments that restore degraded lands and native ecosystems benefit soils by reducing erosion and increasing soil productivity.

Standard Operating Procedures

The SOPs listed here would minimize or avoid adverse effects to soil as a result of treatment activities.

- Assess the susceptibility of the treatment site to soil damage and erosion prior to implementing treatment.
- Prescribe broadcast and other burns that are consistent with soil management activities.
- Plan burns so as to minimize damage to soil resources.
- When appropriate, reseed following burning to reintroduce species, or to convert a site to a less flammable plant association, rather than to specifically minimize erosion.
- When appropriate, leave plant debris on site to retain moisture, supply nutrients, and reduce erosion.
- Time treatments to avoid intense rainstorms.
- Use equipment and methods that minimize soil disturbance and compaction.
- Conduct mechanical treatments along topographic contours to minimize runoff and erosion.
- Minimize use of heavy equipment on slopes greater than 20%.
- Conduct treatments when the ground is sufficiently dry to support heavy equipment.
- Implement erosion control measures in areas where heavy equipment use occurs.
- Consider chaining when soils are frozen and plants are brittle to minimize soil disturbance.
- Prevent oil and gas spills to minimize damage to soil.
- Time treatments to encourage rapid recovery of vegetation.
- Further facilitate revegetation by seeding or planting following treatment.
- Avoid grazing on wet soil to minimize compaction and shearing.
- Minimize use of domestic animals if removal of vegetation may cause significant soil erosion or impact biological soil crusts.

- Minimize disturbances to biological soil crusts (e.g., by timing treatments when crusts are moist).
- Re-inoculate biological crust organisms to aid in stimulating their recovery, if possible.
- Closely monitor the timing and intensity of biological control with domestic animals.
- Conduct burns when moisture content of large fuels, surface organic matter, and soil is high to limit the amount of heat penetration into lower soil surfaces and protect surface organic matter.
- Minimize treatments in areas where herbicide runoff is likely, such as steep slopes when heavy rainfall is expected.
- Minimize use of herbicides that have high soil mobility, particularly in areas where soil properties increase the potential for mobility.

Adverse Effects of Treatments

Effects Common to All Treatments

Regardless of the method used to remove vegetation, vegetation treatments would potentially result in increased rates of erosion and reduced water infiltration, leading to reduced soil productivity. The degree of these effects would vary by region depending on differences in climate, landform, hydrology, soil, vegetation, and land use. In the western U.S., the combination of hydrologic characteristics, steep topography, and slow vegetative growth make soil erosion a serious concern in many regions (Kennard and Fowler 2005).

Erosion results when unstable soils are displaced under the forces of gravity, wind, or water. Although erosion is a natural process, it can increase markedly when vegetation is cleared (BPA 2000). Unnaturally high erosion rates could occur as a result of soil disturbance during the vegetation treatment, or from the resultant vegetation removal and associated decrease in soil stability. Vegetative cover and organic layers covering the soil dissipate corrosive energy of raindrops and help to reduce runoff. Plant roots also strengthen and bind the soil together. Vegetation thresholds for soil erosion may exist (Trimble and Mendel 1995). For example, in areas with scarce vegetation (less than 40% cover), minor reductions in plant biomass have been shown to cause significant erosion, whereas areas with more extensive cover experience little change in soil loss under similar conditions. The effects of loss of plant cover and organic matter are most pronounced on steep slopes.

The risks of increased erosion on public lands would depend on the type of treatment and the local site conditions; high risks would be associated with a variety of direct and indirect effects, such as exposure of bare soil to rain and wind energy, loss of soil structure, removal of surface organic matter, and clogging of soil pores. Increased erosion would potentially result in increased dust and sedimentation, and reduced soil quality. Reestablishing vegetation on the site and maintaining organic matter at the soil surface (e.g., plant litter, forest duff, or mulch) would buffer effects and potentially limit erosion rates.

Removal of vegetation on public lands would also contribute to a short-term reduction in water infiltration into soil in some areas. Furthermore, soil compaction associated with some vegetation treatment methods could reduce infiltration and soil productivity by eliminating pore spaces used for water storage and air exchange. Increased erosion and reduced water infiltration have been observed in pinyon-juniper (Roundy et al. 1978), sagebrush (Brown et al. 1985), and creosote bush (Tromble 1980) treatment areas. These effects would typically last until vegetation was able to recover at the treatment site.

Vegetation management can alter the chemistry of the soil. Treatments that reduce organic matter cover can reduce the productivity of soils by reducing carbon and other nutrient inputs, and by reducing the moisture-holding capacity. Erosion can result in the transport of organic matter and nutrients off site (BPA 2000). Soils with little organic matter to begin with (e.g., most aridisols) are more susceptible to losses of organic matter. Removing nitrogen-fixing plants, such as red alder and ceanothus, can reduce soil nitrogen, and removing logs and other plant material can deprive soils of nutrients provided by decaying material. Removing vegetation can also reduce evapotranspiration, allowing more water to leach soluble nutrients from the soil.

Vegetation treatments can harm or kill soil microorganisms. Mechanical and manual treatments can disturb soil, exposing soil organisms to desiccation and predation. Soil organisms found on or near the soil surface are usually killed by fires, but populations of some bacteria and fungus actually increase after a burn (National Wildfire Coordinating Group 2001). As discussed in the PEIS, some herbicides are toxic to soil organisms.

Soil recovery times vary depending on a variety of factors including site conditions and management approaches. Hilty et al. (2003) determined that the benefits of post-fire revegetation and subsequent recovery of soil surfaces conducive to germination and establishment of perennial grass and shrub communities outweighed the initial short-term disturbance associated with drill seeding after fire. However, a recent study in pinyon-juniper in New Mexico by Wilcox et al. (2003) showed that disturbance-related increases in runoff and erosion remain constant with time, and that for low-slope-gradient sites, disturbance leads to accelerated runoff and erosion, which may persist for a decade or longer. The authors postulated the existence of a slope threshold, below which semiarid landscapes will eventually recover following disturbance and above which there will be no recovery without mitigation or remediation.

Vegetation treatments could result in disturbance to biological soil crusts, which could reduce soil quality and ecosystem productivity. The extent of effects to biological soil crusts would be dependent on the intensity and kind of disturbance and the amount of area covered. The duration of the effects would vary, but biological soil crust recovery rates typically are much slower than the recovery of vegetation. Recovery rates are generally species dependent, and can range from 14 to 35 years for cyanobacteria, 45 to 85 years for lichens, and 20 to 250 years for mosses (Belnap et al. 2001).

The removal or destruction of biological soil crusts could adversely affect soils by increasing susceptibility to erosion, encouraging weed establishment, and reducing nitrogen inputs and water infiltration (Evans and Belnap 1999; Belnap et al. 2001). Control of invasive plant species, such as soft brome, can be protective of biological soil crusts by maintaining a natural fire cycle, avoiding excessive shading, and avoiding excessive buildup of a litter layer, which can essentially bury biological crusts.

Effects of Fire Treatments

The BLM proposes to treat approximately 2.1 million acres of public lands annually using fire, twice the number of acres currently treated using this method. Fire affects soil primarily by consuming litter, organic material, dead and down woody fuels, and vegetative cover. Fire treatments would affect physical, chemical, and biological soil processes directly by transferring heat into soil, and indirectly by changing vegetation and altering nutrient and organic matter dynamics. Depending upon the severity of the fire, changes would be beneficial or deleterious (Neary et al. 1999).

Fire treatments would potentially alter the physical properties of soil by consuming organic matter, modifying soil structure, and harming soil organisms. Because organic matter contributes to surface soil structure and porosity, burning of organic matter during fire treatments could result in soil structure degradation. Such degradation can persist from a year to decades, depending on the severity of the fire and post-fire ecosystem conditions. Persistent soil structure deterioration following fire would be greatest in cold and arid climates (Neary et al. 1999). Surface runoff and soil erosion would increase after severe fire as a result of these physical changes.

Fires that consume large quantities of surface organic matter can reduce the productivity of soils by reducing moisture-holding capacity. Soils with little organic matter (e.g., many aridisols) would be most susceptible to losses of organic matter through fire treatments, especially from frequent burns. Soils with high organic matter content, such as permafrost soils in Alaska (gelisols) would tend to burn slowly, and it is unlikely that the organic matter would be completely consumed by fire.

Fire treatments could cause long-term changes in soil temperatures, with increases in both hot and cold temperature extremes caused by the loss of shade and insulating organic matter, and by the accumulation of blackened fire residues. Loss of soil insulation can influence the dates of both the first and last frosts and freezes of soil and understory vegetation (Fisher and Binkley 2000). Warmer soils increase the rate of decomposition and nutrient availability to post-fire vegetation, which is especially important in Alaska, where permafrost is present. Soil temperatures usually increase in tundra soils after a fire because the fire removes the overstory vegetation, blackens the surface, and removes organic matter that insulates the soils from summer warmth (Viereck and Schanderlmeier 1980, National Wildfire Coordinating Group 2001). The depth to which the permafrost melts each summer (active layer) can increase several feet after a fire, and it may take many years before the depth of the active layer decreases to its original thickness.

A severe fire could cause water repellency in soil, resulting from the condensation of organic compounds onto soil particles. Water repellency is a common phenomenon in chaparral soils of southern California. Water repellent soil layers eliminate water infiltration,

thereby increasing surface runoff and erosion (DeBano 2000). This process is most likely to occur in coarse-textured soils (McNabb and Swanson 1990), and has also been frequently reported in arid soils of the southwest (Salih et al. 1973). Water repellency has not been reported in Alaska (Viereck and Schandelmeier 1980), and would be unlikely to occur on public lands in that state.

Fire treatments would alter soil chemistry by volatilizing organic matter and by changing the form, distribution, and quantity of nutrients. A reduction of incorporated organic matter as a result of fire is especially important in arid, semi-arid, and forested sites because many of the nutrients on these sites are tied up in the organic matter. Burning surface organic matter could also cause the loss of some nutrients (primarily carbon, nitrogen, and sulfur) through volatilization, and could cause soils to become less acidic.

Fire treatments would kill some soil organisms on the site including microorganisms, microarthropods, biological soil crusts, and plant roots. The effects of fire on soil microorganisms would be dependent on fire severity (Neary et al. 1999). Observed effects have ranged from no detectable effect in the case of infrequent, low severity fires, to total sterilization in very severe fires. There have been few scientific studies of the responses of soil macroinvertebrates to fire. It appears that the response is driven by changes in habitat structure or by changes in the amount or the quality of food resources after fire.

Biological soil crusts could be negatively affected by fire, depending on fire severity. Algae are generally the first to recover from fire and can form a protective crust within 5 to 10 years after fire. Lichens and mosses are slower to recover and may take 10 to 20 years to achieve substantial cover (Johansen and Rayburn 1989). In some cases, such as a low severity fire treatment, crust aggregation might persist to some degree even though crust organisms are killed. In a study of soil crusts after a wildfire, a substantial reduction in the diversity and richness of biological soil crust species was observed. The study showed increased cover of short mosses and reduced cover of lichens and tall mosses growing on shrub hummocks (Hilty et al. 2004).

Fire severity would determine the degree of effects to soil, with more severe fires causing more extensive and long-term soil changes. Of the three components of severity (heat, duration, depth), duration would likely contribute most to belowground soil damage (Certini 2005). The adverse effects of concentrated heat have been observed after the burning of pinyon-juniper slash piles, which has resulted in soil sterilization (USDI BLM 1991a). Low to moderate severity fires would have fewer adverse effects on soils, and in some cases might even improve soil nutrient availability. In general, subsurface heating would be greater in forestlands than rangelands, as rangelands generally support lighter fuel loadings and frequently result in fires of shorter duration that produce less subsurface heating. Depth and condition of duff and soil moisture content are important regulators of subsurface heating, with less subsurface heating in wet duff than in dry duff (National Wildfire Coordinating Group 2001). In some cases, subsurface heating could be substantially less in forests with damp soil and little duff, compared to rangelands with dry soil and dense accumulations of duff. Recovery of soil quality after a treatment would depend on the burning intensity and its effects on soil processes, and also on the previous land-use practices (Neary et al. 1999).

Ground equipment associated with burn treatments, such as equipment used to create firelines, could disturb soils, contributing to compaction and an increased risk of erosion. In Alaska and other cold areas with permafrost, the construction of firelines can accelerate thawing in soil to depths beyond those typically reached during the fire itself, potentially resulting in land subsidence, erosion, and gullying (Viereck and Schandelmeier 1980). These effects would be localized in their extent. Most fires, however, would be ignited using aerial methods. Therefore, ground operations would be limited, reducing effects to soil from mechanical pre-treatment activities. Effects of mechanical treatments are discussed further below.

Effects of Mechanical Treatments

Approximately 2.2 million acres would be treated using mechanical methods under the proposed treatment program, which is a 3-fold increase from current levels. Most mechanical treatments would occur on public lands in Nevada, Idaho, Oregon, and Utah. The effects of these treatments on soil would depend on the following: 1) the amount of soil exposed during the treatment; 2) the effect of ground disturbance on soil properties; and 3) the site conditions, especially slope and patterns of precipitation. Mechanical treatments would include methods that do not directly disturb the soil, such as mowing, shredding, mastication, and roller chopping; and methods that do directly disturb the soil, such as plowing, disking, blading, and chaining (USDI BLM 1991a). The *Final EIS Vegetation Treatment on*

BLM Lands in Thirteen Western States (USDI BLM 1991a) provides a detailed discussion of effects to soil from mechanical treatments; much of the following discussion is based on information provided in that document, or in references therein, unless otherwise noted.

Soil Exposure

Mechanical treatments would affect soils by removing vegetation and by disturbing or removing topsoil. Because plant and litter cover protect the soil, and roots hold the soil in place, removal of plant materials exposes soil. Exposed soils are vulnerable to increased erosion and drying out. About two-thirds of treatments would involve the removal of vegetative cover; the remaining one-third would consist of drill seeding. The risk of increased erosion would be reduced where some vegetation or organic matter was left in place.

Soil Disturbance and Compaction

Mechanical treatments would result in soil disturbance and compaction at the treatment site. The specific effects to soils would depend on the type and area of treatment, site soil texture and structure, and soil moisture at the time of treatment. About 15% of mechanical treatments that remove vegetation would involve mowing, which does not disturb soil directly, but which can result in compaction.

Approximately 85% of mechanical treatments would involve cutting, crushing, shredding, and logging and similar treatments. Crushing, shredding, and cutting (followed by chipping or shredding) can result in all or most of the organic material remaining on site. The application of large quantities of fresh, woody organic material to the soil surface can provide protection to the soil in the form of the mulching effect. It is well documented that the mulching effect results in attenuated soil temperatures and increased soil moisture retention (Resh et al. 2005). Other effects such as reduced erosion and runoff, increased infiltration, changes in soil carbon, and reduced compaction are expected. Adding large amounts of organic matter to the soil surface may result in smothering biological soil crusts and in short-term reductions in nutrient availability for plant reestablishment.

Use of certain mechanical treatments would directly disrupt biological soil crusts. Crusts are sensitive to compaction by vehicles and other heavy equipment. The removal or destruction of biological soil crusts could adversely affect soil quality by increasing susceptibility to erosion, reducing nitrogen inputs, infiltration, and potentially encouraging weed establishment (Evans and Belnap 1999; Belnap et al. 2001). The duration of the effect would vary, but recovery of biological soil crusts typically takes much longer than the recovery of vegetation. Recovery rates are generally species dependent, and can range from 14 to 35 years for cyanobacteria, 45 to 85 years for lichens, and 20 to 250 years for mosses (Belnap et al. 2001).

Soils with physical surface crusts (non-living crusts that often form in arid regions on fine textured and low organic matter content soils; not to be confused with soil biological crusts discussed in the preceding paragraph) have low water infiltration rates. Mechanical treatments that disturb the soil, such as disking, blading, and tilling, can improve infiltration by breaking up surface crusts (Wood et al. 1982); however, these areas would then be potentially susceptible to increased rates of erosion. Disking and tilling would comprise about 10% of treatments. If these treatments result in increased surface roughness (e.g., pits or furrows), benefits could occur through the capture of precipitation and potential increased infiltration.

In general, use of heavy equipment on treatment sites would be expected to result in increased soil compaction, and heavy equipment can shear and rut wet soils. Compaction by vehicles and other heavy machinery can reduce soil pores and limit water infiltration, soil aeration, and root penetration. Wet, fine-textured soils would be the most susceptible to compaction, while coarse, sandy soils would be the least susceptible. The magnitude of soil compaction would also be dependent on the type and weight of equipment used. Using tracked or low-pressure tires distributes vehicle weight over a larger area, thus reducing the pressure on soil as compared to conventional tires. Compaction can also be avoided by covering the area with mulch or other material that serves to protect the soil surface.

Mechanical treatments such as blading, tilling, plowing, chaining, or soil disking that may disturb several feet of soil would likely kill or harm organisms found near the surface and destroy underground tunnels and dens used by animals for shelter. Blading and chaining can result in complete disruption and permanent displacement of the topsoil with dramatic loss in soil quality and function. Extensive studies on soil quality under tillage have shown that the fungal component of the soil community decreases or even disappears, while other microorganisms remain, but are less abundant overall.

Site Conditions

Soil texture and morphology, site topography, and rainfall affect a soil's response to mechanical treatments. On sites that support coarse-textured soils with high infiltration rates, or clayey soils with low infiltration rates, some mechanical treatments could result in little change in infiltration rates. For most other soils, mechanical treatments that break up the soil surface and create furrows and ruts would increase water infiltration. Avoidance of mechanical treatments in windy areas with poorly structured soils would help to reduce loss of soil to wind erosion.

Erosion can be prevalent on slopes greater than 20%. Thus, mechanical methods that disturb the soil, such as disking, tilling, and blading, should be avoided on steep hillslopes. Slopes of 12% to 15% allow chaining on the contour, and slopes of 30% are recommended as a maximum. Orienting furrows parallel to the hillslope during any type of mechanical treatments would help reduce water runoff and erosion.

Soil Orders

Over half the mechanical treatments would occur in Nevada, which is dominated by aridisols. These soils are characterized by an extreme water deficiency, have low organic matter content, support limited vegetative cover, and are prone to developing hardpans that limit depth of water infiltration. Plowing (36% of treated acres in Nevada), chaining (7%), and disking (5%) would reduce soil structure and could lead to increased erosion, especially if revegetation did not occur. Loss of soil structure can also lead to decreased infiltration. Disking of sagebrush followed by drill seeding of beardless bluebunch and bluebunch wheatgrass have been used successfully to increase herbaceous cover and water infiltration.

Tundra and boreal forest soils are susceptible to soil disturbance and increased erosion from heavy equipment, although the BLM does not propose to conduct mechanical treatments in Alaska at this time. Use of specialized equipment that minimizes the amount of surface disturbance and equipment weight placed upon the ground; limiting heavy equipment travel to the winter months when the tundra is covered by a protective layer of snow and ice; and use of ice roads during winter have greatly minimized the amount of damage that occurs on tundra and other soils in Alaska (USDI BLM 2005c).

Mollisols, which occur on 15% of public lands, typically have a well-developed organic layer and are common in grasslands. Most treatments in grasslands would consist of seeding and revegetation of treatment sites. Mechanical treatments of grasslands are done to reduce less desirable warm-season species and to increase production of cool-season species. Because treated slopes are gentle and plant cover recovers rapidly after disturbance, erosion potential is low. These soils can be prone to wind erosion unless tilling and ripping are done between strips of vegetation, or stubble is left on the ground.

Entisols, which are found on 9% of public lands, are mineral soils that lack significant profile development. Grasses, desert shrubs, and pinyon-juniper are common vegetative types. Mechanical treatments are generally not recommended for desert shrubland. Replacing perennial plant cover by revegetation is usually necessary after treatment, and revegetation is rarely successful. Mechanical methods used to control pinyon-juniper include chaining, blading, chipping, shredding, and handslashing.

Alfisols are found on 2% of public lands, primarily in the forested mountains of Oregon and California. Mechanical restoration treatments in forest vegetation types consist primarily of removing small diameter trees, removing excessive amounts of downed woody debris, and increasing tree canopy spacing (reducing crown bulk density) by thinning dominant and codominant trees. Excess residue from these treatments is either removed from the site using harvesting equipment, burned in place, or piled and burned on site. Residue piling typically consists of either dozer piling or hand piling. Soil disturbances from mechanical treatments may cause soil compaction and loss of soil productivity. Construction of slash piles may also remove some duff, increasing the potential for erosion, especially on steeper slopes. Using equipment that minimizes damage to the soil, traveling on existing roadways, limiting activities to the drier months, maintaining duff, and retaining organic material through mulching are all practices that would protect forest soils and minimize erosion.

Equipment

Treatments such as blading, tilling, plowing, chaining, or soil disking drastically disturb the top 8 to 12 inches of the soil profile, while ripping may go as deep as 36 inches. Under the proposed treatment program, these activities would comprise about 15% of all mechanical treatments. Other types of mechanical treatment, such as

roller chopping, maceration, and mowing, directly disturb only the top few inches of topsoil and organic matter. During mechanical thinning to reduce fuel loads, cutting, skidding, and decking all can result in disturbance to soils. Plowing, tilling, or disking would primarily be used in areas with little vegetation, where soil disturbance would help prepare the seedbed for revegetation. Their use in wildland management is largely limited to restoration sites where soils are already badly disturbed. Roller chopping, maceration, and mowing result in minimal soil disturbance, reduce the aboveground biomass, and can provide a layer of mulched organic material to protect the soil from erosion and other effects. With some systems, mowing and mulching occurs in front of the machine, leaving a cushion of mulch to travel over, thereby reducing surface disturbance.

The effects of chaining on soil and vegetation have been an issue of concern in recent years. Chaining may cause soil disturbance, but the plant debris can be left in place to minimize runoff and erosion, shade the soil surface, and maintain soil moisture and nutrient recycling. Alternatively, the debris can be burned to facilitate seeding, improve scenic values, and eliminate potential rodent habitat. Under the proposed action, about 6% of mechanical treatments would involve chaining, which is twice the current level. Chaining treatments would be evenly split between treatments involving evergreen woodland—most likely pinyon-juniper—and evergreen shrubland, including sagebrush and other desert shrubs. Over half of the proposed chaining treatments would occur in Utah.

There is some potential for contamination of the soil by oils and fuels associated with mechanical equipment. The release of these substances into soil could result in a localized area of reduced water infiltration and reduce plant growth. The use of SOPs when treating vegetation, such as using sorbents under vehicles when fueling and servicing in the field, cleaning up spills immediately, and fueling equipment away from water bodies and sensitive soils, would reduce the likelihood of effects to soil caused by petroleum products.

Effects of Manual Treatments

Under the proposed treatment program, manual treatments would be used on about 5% of public lands. Nearly all manual treatments would involve pulling or cutting vegetation with non-motorized hand equipment or chainsaws. Manual treatments would have less direct effect on soil than the other proposed treatments. Laborers and vehicles accessing the site could disturb topsoil and/or surface organic matter, providing prime conditions for re-invasion by weedy species; however, the extent of this disturbance should be limited. Coarse-textured soils and steep slopes would be the most fragile, and extensive areas of disturbance could result in increased erosion rates. There is the potential for some contamination of the soil from petroleum products used in hand-held power equipment, but these effects would be extremely localized.

Leaving vegetation residues on the soil surface, or mulching and spreading them after a manual treatment, would help protect the soil surface. Pulling weeds out of the ground slowly and carefully, and replacing soil in disturbed areas where possible, would further minimize effects to soil at manual treatment sites. Furthermore, limiting the number of people and the amount of time spent in each site would help minimize trampling (Tu et al. 2001).

Although manual treatments would help reduce fuel loads and populations of invasive species, the associated benefits to soil on public lands would be limited. Since manual labor is slower and more expensive than other forms of treatment, the amount of area treated using this method is generally limited.

Effects of Biological Treatments

Approximately 8% of public lands would be treated using biological control methods, with half of these treatments occurring in Idaho, Montana, and Wyoming. Nearly two-thirds of all biological treatments would involve containment by domestic animals (such as livestock), as compared to 75% of biological treatments using domestic animals at present. Most of the remaining biological treatments would utilize insects. Pathogens would be used on less than 100 acres annually. Biological control of vegetation using domestic animals would result in some effects to soil on public lands. The effects would be dependent on the type of animal used and the intensity and duration of the treatment in a particular area. Goats and other browsing animals are used more frequently than cattle. When containment by domestic animals is used specifically to control unwanted vegetation, the BLM closely monitors animal stocking rates, activities, and time of use.

The action of animal hooves would cause some disturbance, shearing, and compaction of soil, increasing its susceptibility to both water and wind erosion. These effects can be severe in heavily grazed areas, but may be less so under light and moderate grazing intensities (Trimble and Mendel 1995). Severe

compaction often reduces the availability of water and air to the roots, sometimes reducing plant vitality. Grazing disturbance can be extensive enough to transform the runoff regime from variable source areas to overland flow, facilitating increased rates of erosion. Soil organisms can be negatively affected by the loss of surface organic matter, soil compaction, and other alterations to habitat. Recovery from grazing-induced compaction is site-dependent, with recovery observed within 1 year at a site with frequent freeze-thaw events and high soil organic matter content (Wheeler et al. 2002).

Domestic animals could alter nutrient cycling processes in soil by depositing organic nitrogen in urine and feces. Many years of grazing on a site can result in increased soil nitrogen (Dormar and Willms 1998), which could increase productivity in nitrogen-limited ecosystems of the arid west. In some instances, the formation of soil nitrogen hotspots could increase localized productivity to such a degree that weeds would be favored over native plants adapted to low nitrogen conditions (Evans and Ehleringer 1993).

Domestic animals could damage biological soil crusts at treatment sites through physical disruption, resulting in reduced species richness and lichen/moss cover (Belnap et al. 2001). Resistance to disturbance generally decreases as the organisms become more morphologically complex, with cyanobacteria the most resistant to disturbance. In addition, soil compaction alone can lead to changes in crust species composition, with potential loss of diversity. Recovery from these effects could take many years. In one study, the percent cover of crust organisms increased from 4% to 15% during the first 18 years after grazing exclusion, and then increased only an additional 1% during the next 20 years (Anderson et al. 1982).

The effects of containment by domestic animals can be minimized by following a planned vegetation management program that limits the number and amount of time livestock remain on any one site, and that uses fencing and salt/nutrition blocks to restrict livestock to treatment areas and keep livestock away from riparian and other sensitive areas.

Effects of Chemical Treatments

Herbicides may affect soil through plant removal resulting in changes in physical and biological soil parameters. As vegetation is removed, there is less plant material to intercept rainfall and less to contribute organic material to the soil. Loss of plant material and soil organic matter can increase the risk of soil susceptibility to wind and water erosion. The risk for increased erosion would be temporary until vegetation was reestablished. If herbicide treatments lead to revegetation with native plants, soil stability may be improved relative to sites dominated by invasive plants.

There are few studies on herbicide effects on biological soil crusts. Therefore, caution should be used when applying these chemicals to soils supporting biological soil crusts (Belnap et al. 2001) or to areas where management goals include crust recovery. Herbicides may also adversely affect soil micoorganisms and macroorganisms, leading to poorer soil productivity. A more detailed discussion of the effects of herbicides on soil is in Chapter 4 of the PEIS.

Beneficial Effects of Treatments

Benefits of Improving Ecosystems and Restoring Natural Fire Regimes

Findings and comparisons of studies in forested and rangeland environments concluded that forest and range landscapes that resemble conditions within historical ranges of variability (i.e., they contain native plant communities in natural mosaic patterns and have relatively uninterrupted disturbance regimes) provide favorable conditions for soil functions and processes that contribute to long-term sustainability of soil productivity (Hole and Nielsen 1970; Munn et al. 1978; Cannon and Nielsen 1984).

Substantial changes in disturbance regimes, especially changes resulting from fire suppression, timber management practices, and livestock grazing over the past 100 years, have resulted in moderately to highly altered plant composition and structure and landscape mosaic patterns, compared to historical conditions. Restoration activities that move forests and rangelands toward historical ranges of variability would provide favorable conditions for soil functions and processes that contribute to long-term soil productivity at a broad scale (USDA Forest Service and USDI BLM 2000b).

Although treatments would have short-term effects on soil condition and productivity, it is predicted that disturbance effects resulting from restoration activities would be less severe than fire effects and erosion caused by traditional management activities. Furthermore, monitoring and evaluation, integrated with an adaptive management approach, would result in adjustment of treatment design and implementation to reduce soil disturbance to levels similar to historical conditions.

In some instances, fire treatments could potentially have beneficial effects on soil (National Wildfire Coordinating Group 2001). Fire raises the pH of soil, especially soils that are naturally acidic. Since nutrient availability is related to soil acidity, elements critical for plant growth, such as phosphorus and nitrogen, become more available to plants as the soil pH increases. However, availability may decrease for some nutrients, such as phosphorus above a pH of 7. Fire also helps to release nutrients that may be tied up in forms that are unavailable to plants, such as woody material. The burning of surface organic matter releases some nutrients onto the soil in the form of ash, resulting in an increase in available calcium, phosphorus, and potassium. These available nutrients would be used by new vegetative growth or could be leached by precipitation (DeBano et al. 1998). In some cases, prescribed burning may reduce erosion by releasing existing understory plants and establishing new plants on sites that may have had little vegetative cover before burning (USDI BLM 1991a).

Benefits of Removing Invasive Species

Vegetation treatments that reduce or eliminate invasive species could be beneficial to soil quality. If these treatments were to result in increased native plant cover on sites degraded by weedy vegetation, soil quality would begin to rebound. For example, watershed-level treatments that remove the invasive mesquite tree have been shown to increase the productivity of perennial grasses, with resulting soil erosion losses five times less than those observed in nearby untreated watersheds (Martin and Morton 1993).

Sites with a large component of invasive plants may be at a higher risk for erosion than sites that support native vegetation. Invasive plants can increase the potential for wind or water erosion by altering fire frequency or producing chemicals that directly affect soil quality or organisms. These negative effects include increased sediment deposition and erosion, and alterations in soil nutrient cycling. For example, millions of acres of grassland in the Great Basin have been taken over by downy brome. A study that compared soil organisms in native grasslands to those at a site invaded by soft brome found that the soft brome caused negative changes in most levels of the soil food web (Belnap and Phillips 2001). Soft brome invasion also appears to change soil physical characteristics and alter the cycling of carbon and nitrogen (Norton et al. 2004).

Benefits of Reducing Risk of Wildfire

Vegetation treatments may benefit soil quality by reducing the risk of wildfire. Wildfires generally occur when soils are driest, resulting in hot soil temperatures, loss of nutrients, and consumption of soil organic matter. Catastrophic, stand-replacing fires in pinyon-juniper woodlands and ponderosa pine forests of Arizona, for example, caused loss of 75% to 100% of the soil organic matter (Neary et al. 1999). Given the ability of an unplanned, uncontrolled, severe wildfire to cover a large geographic area, the detrimental effects of wildfire on soil quality have the potential to be high. Thus, vegetation management that reduces this risk would be beneficial to soil resources on public lands.

Benefits of Mechanical and Biological Treatments

Mechanical treatments that ultimately result in improved plant cover and diversity can improve habitat for soil organisms. Chaining is a common and relatively inexpensive mechanical method of converting woodlands to grasslands. It is effective at uprooting and killing trees, such as pinyon and juniper, in preparing sites for seeding, and in adding litter to the soil surface (Grahame and Sisk 2002).

The Utah Department of Wildlife (2005) indicated that percent cover of perennial vegetation can be increased with chaining and planting, and advocates evaluation of site suitability prior to this type of vegetation treatment. The agency found that chaining was effective in treating pinyon-juniper sites on steep and rocky hillslopes that could not be treated using other methods. Chaining reduced the cover provided by pinyon-juniper trees and scattered debris over the site, holding soils in place until herbaceous plants became established. Chaining also efficiently thins and opens dense stands of sagebrush, while covering seeds of herbaceous species, which allows establishment of perennial herbs or development of suppressed understory herbs while retaining sagebrush in the midstory.

Benefits of Chemical Treatments

Herbicide treatments would benefit soil by removing invasive species and other unwanted vegetation and allowing restoration of native vegetation and return of natural fire regimes. In many situations, herbicides are the only, or the most effective, method for controlling invasive vegetation. For example, mechanical and manual methods are not appropriate for large-scale treatments (hundreds to thousands of acres), or for treatments in remote areas that are difficult to access.

Water Quality and Quantity

Introduction

Invasive plants can create or exacerbate conditions that modify water quantity and quality. Directly or indirectly, invasive plants can affect streambank stability, sediment, turbidity, shade and stream temperature, dissolved oxygen, and pH. Invasive plants can also reduce water quantity. For example, tamarisk and giant reed can alter stream form and can use more water than native vegetation (USDA Forest Service 2005).

Vegetation treatments could affect both surface water and groundwater quality and quantity. Removal of vegetation could affect surface water by increasing surface runoff, promoting erosion and sedimentation, reducing shading and increasing water temperature, and limiting the amount of organic debris entering water bodies (BPA 2000). Potential groundwater effects would vary relative to type of treatment and herbicide applied at a specific location. These effects could be short-lived, recovering with vegetation reestablishment or dissipation of chemical contaminants (Satterlund and Adams 1992). The extent and duration of effects would be dependent on the geographic location, and the extent of vegetation removal, as well as on revegetation management practices.

Scoping Comments and Other Issues Evaluated in Assessment

Many comments were received concerning water quality and water issues. Some felt that important issues should be considered on a watershed basis. One respondent felt that vegetative restoration to increase infiltration and reduce runoff and erosion is important. Assessing treatment effects on water yield, quality, and salt concentration was recommended. Respondents suggested restoring natural flood regimes and degraded fluvial systems. Other respondents indicated that erosion and stabilization of treated areas should be addressed, and the effects of burning on watershed stability should be researched.

There was concern about the effects of saltcedar on water quality, quantity, and riparian areas, with one respondent noting that water yield on the Mojave River has not increased since the removal of the saltcedar. One respondent was concerned for the species diversity in vernal pools and springs. Others felt that water for wildlife should be of good quality and quantity, and that salt loading in the Colorado and other rivers is an important issue to address.

There was a considerable amount of concern from respondents regarding the negative effects of herbicides on water quality. Numerous respondents felt that the PEIS should address herbicide runoff, overspray, drift, and the effects and benefits of herbicide use in riparian areas. Respondents felt that the effects of decay products of herbicides in water should also be addressed. There was specific concern about the effects of herbicide use on aquatic life, the degradation of water quality, and the risk of herbicides accumulating in hydrological systems. Herbicide-related issues are addressed in more detail in the PEIS.

Resource Program Goals

Approximately 5% of acres would be specifically treated to improve watershed functions by restoring streambank stability and channel integrity, improving vegetation diversity, and restoring habitat function. Of these acres, approximately 60% would be treated mechanically and 20% would be treated using fire. Seedbed preparation and seeding would comprise nearly all of the mechanical treatments.

The Soil, Water, and Air Management program oversees BLM efforts to improve water quality. The program has a goal to implement water quality improvement prescriptions, including vegetation treatments, in 20% of watersheds within priority sub-basins that do not meet state or tribal water quality standards. In addition, the BLM should be achieving an upward trend in the condition of uplands in 50% of watersheds within priority sub-basins. As of FY 2005, prescriptions had been implemented in 9% of watersheds and an upward trend in condition was observed in 34% of watersheds (Office of Management and Budget 2005.

The objectives of treatments would be to reduce hazardous fuels, reduce the risk of fire in the WUI, and improve habitat for fish and wildlife. These treatments, however, would also likely improve plant community structure and function, benefiting water resources in the treatment area.

As discussed below, fire exclusion policies, buildup in hazardous fuel levels, and increase in acreage dominated by invasive vegetation have led to more frequent fires of greater severity and duration and increased soil erosion over many areas of the West.

These conditions have often led to deterioration in water quality in affected areas (USDA Forest Service and USDI BLM 2000b). Although disturbances from fire, wind, plant disease, grazing by wildlife, floods, and other factors will always be important in shaping ecosystems in the western U.S., efforts by the BLM to restore vegetation to more natural conditions, reduce the frequency of catastrophic fires, and slow hazardous fuels buildup should lead to improvement in water quality in treated areas.

Standard Operating Procedures

Standard Operating Procedures used to reduce adverse effects to water resources from non-herbicide vegetation treatments include prescribing burns that are consistent with water management objectives; planning burns to minimize negative impacts to water resources; minimizing burning on steep hillslopes or revegetating hillslopes shortly after burning; maintaining vegetated buffers between treatment areas and water bodies; and maintaining a vegetated buffer and minimizing the removal of vegetation near drinking water sources. Additionally, the BLM would not wash equipment or vehicles in water bodies, and would minimize use of domestic animals near drinking water sources and adjacent to water bodies if trampling is likely to cause soil erosion. Procedures to minimize the effects of herbicide treatments on water resources are presented in Table 2-5 of this PER and Table 2-8 of the PEIS.

Adverse Effects of Treatments

Effects Common to All Treatment Methods

Water Quantity

Removal of vegetation could temporarily affect water flows by altering the magnitude of low flows and the frequency and magnitude of peak flows, as compared to pre-treatment conditions. The removal of vegetation, especially over large areas, would improve groundwater availability over the short term by reducing water lost through evapotranspiration of plants. Low flows, which are dependent on the quantity of groundwater, would temporarily increase. These changes would be minor and usually short lived, unless long groundwater flow lines were involved (Sturges 1977, Satterlund and Adams 1992).

Several invasive plant species that occupy large expanses of public lands may play a role in the availability of groundwater. For example, western juniper that has increased markedly over the last 100 years has outcompeted mountain big sagebrush in parts of central Oregon. Removal of western juniper in some areas was followed by an increase in flow from nearby springs, so increase in flow may be related to removal of western juniper. However, Schmidt (1987) concluded that there is little reason to expect large responses in streamflow to control of pinyon-juniper woodlands, and Belsky (1996) and Wilcox (2002) noted that there have been no documented increases in streamflow as a result of juniper control and that the relationship between streamflow and the abundance of pinyon-juniper trees is inconclusive.

The removal of vegetation could cause short-term increases in surface runoff, as there would be reduced interception of precipitation and evapotranspiration by plants. At a desert shrub and evergreen woodland site in New Mexico, one study documented a strong correlation between soil infiltration and vegetative cover (Wilcox et al. 1988). Effects of vegetation treatments on surface runoff and groundwater recharge would vary by site and post-treatment restoration.

Vegetation treatments that affect the interception of precipitation could increase the magnitude and frequency of peak flows and could subsequently alter the physical characteristics of the stream channel. If channel morphology has not been substantially altered, effects should persist until vegetation is reestablished. Restoration of native plant communities and vegetation structure would ultimately improve hydrologic function and watershed processes long term (USDA Forest Service and USDI BLM 2000b).

Water Quality

Increased surface water runoff resulting from vegetation removal could contribute to increased erosion, particularly in high gradient watersheds. This could further contribute to increased sediment loadings and the potential reduction in surface water quality. Sediment, which has been described as the greatest non-point source of pollution, increases turbidity and contributes to reduction in dissolved oxygen (Spence et al. 1996).

Vegetation treatments could affect water quality by reducing nutrient uptake by plants, resulting in a pulse of nutrients to nearby water bodies. Soluble nutrients, such as nitrogen, would likely enter streams or other water bodies via groundwater, while nutrients adsorbed to soil particles (e.g., phosphorous) could be carried to surface water in runoff. Nitrogen as nitrate is most often

the nutrient of concern. Streams draining red alder forest in the Pacific Northwest, chaparral in California, and grasslands in California and Arizona have shown increased nitrate concentration following vegetation disturbance (Binkley and Brown 1993). Nutrient enrichment of aquatic systems can lead to algal blooms and eutrophication (i.e., deficiencies in oxygen) of lake and stream systems (Getsinger 2004).

Removal of streamside vegetation could increase water temperatures resulting from the loss of stream shade (Clark 2001). In coldwater systems, resulting temperature increases would contribute to water quality degradation and potential effects to coldwater fisheries. In the Pacific Northwest, the majority of streams on federally-administered forestlands are impaired by elevated stream temperatures (USDA Forest Service 2005).

The removal of hazardous fuels from public lands would result in a long-term benefit to surface water quality by reducing the risk of a future high-severity wildfire on the treatment site. A high-severity wildfire that removes excessive plants and litter could subsequently increase surface soil erosion and mass failures, resulting in short-term increases in stream flows (Debano et al. 1998). In addition, fire retardants could affect water quality. Fire retardants that are used most extensively for emergency suppression contain nitrogen and phosphorus that could cause nutrient enrichment of surface waters. When mixed with water and exposed to ultraviolet radiation, fire retardants break down into hydrogen cyanide, an extremely toxic substance (Fresquez et al. 2002). In highly alkaline waters, toxic concentrations of ammonia can also be produced. Finally, use of water from nearby sources to extinguish wildfires could reduce the quantity of surface water resources, particularly in arid climates or during dry seasons.

Reduced infiltration could have negative effects on groundwater recharge, leading to a decrease in groundwater supply and a decrease in the magnitude of base flows. The magnitude of effects to runoff and infiltration would vary depending on the treatment used, local conditions, and other management steps.

Loss of vegetation and erosion in areas with extensive natural sources of salt in the soil can lead to higher levels of salinity in nearby water bodies. Natural sources of salt are responsible for about half of the salinity in the Colorado River Basin, and human activities, including soil disturbance, irrigation, and reservoir evaporation have increased the salinity level in the Colorado River Basin (USGS 1996a).

In the upper Colorado River Basin, salt enters the Colorado River and its tributaries from groundwater flows, surface runoff, and point sources such as saline springs and flowing wells. Dissolution of evaporite deposits in the upper Colorado River Basin results in highly saline ground water that ultimately contributes the largest amount of salt to the Colorado River System. The natural salt load for the Colorado River at Lees Ferry, Arizona, is estimated to be about 5.2 million tons per year. Contributions from BLM lands are included in this estimate. Surface runoff from public lands above Lees Ferry is estimated to contribute about 700,000 tons of salt per year, or about 14%. The remaining 4.5 million tons are contributed primarily by groundwater inflow and saline springs, and runoff from other federal, tribal, state, and private lands.

Effects of Fire Treatments

The potential effects of fire on water resources would depend largely on the severity and size of the fire, with a low severity burn being less likely to degrade water quality and quantity than a severe burn, and a small fire affecting a smaller surface area than a large fire. In addition, the closer the fire is to a water body, the more likely it would be to affect water quality.

Vegetation treatments using fire have produced mixed results in attempts to increase water yield from watersheds. For example, conversion of shrublands to grasslands has been thought to increase off-site water yield (Clark 2001). After large, "clean" fires, water retention by litter and debris and water loss via transpiration both decrease, offsetting the loss of water through evaporation and leading to an increase in surface water runoff. However, the effect is quickly reduced as vegetation and litter return. Small springs and streams near burned areas often produce greater amounts of water and flow longer into the summer (USDI BLM 1988a). A similar relationship has been noted in forested watersheds after wildfires. Annual water yields and short-term baseflows generally increase if overstory vegetation is removed by fire, only to return to preburn levels as vegetation recovers. Prescribed burning generally has little effect on water yields (Beschta 2000).

In Utah, soil water patterns were studied in pinyon-juniper woodlands in areas that were untreated, chained, and burned, and chained and grazed (Gifford 1982). The untreated sites had the lowest soil water, and grazing of

chained sites did not affect soil water. However, burned sites had significantly more water the second year after treatment. A study of soil water in burned and unburned areas in a Mediterranean shrubland showed a similar pattern—soil moisture content was higher in burned areas (Silva at al. 2002).

The burning of vegetation would be expected to lead to an increase in surface runoff and sediment inputs to water, and a decrease in infiltration and thus groundwater recharge. The amount of runoff would be a factor of the timing and severity of the fire, the slope of the treatment site, and the timing, amount, and intensity of precipitation. High severity fires tend to burn much of the organic material on a site, exposing mineral soil, and sometimes forming hydrophobic soil layers Erosion, runoff, and water quality are often unaffected on level areas after a low severity prescribed burn, whereas adverse effects to water resources may persist for 9 to 15 months on moderate slopes, and for 15 to 30 months on steep slopes (Wright et al. 1976). Wright et al. (1976) further determined that average sediment yield was less than 0.01 tons per acre during the first 6 months after burning from level sites, but was about 10-fold to 100-fold greater on moderate to steep slopes. If a fire was of low enough severity that litter and duff layers were undamaged during the burn, effects to water resulting from runoff and erosion would be minimized (Beschta 2000). Additionally, burn timing is important; prescribed fire conducted prior to a precipitation event would have the greatest risks of increased surface runoff and sedimentation. Generally, low severity burns would result in no changes to stream flow. This is in contrast to conditions resulting after large or severe fires that increase stream flows for several years following the fire (Brooks et al. 1997). Sedimentation may be reduced by avoiding burns on steep slopes; retaining buffers along water bodies; revegetating treated sites; and minimizing use of burned sites by equipment, livestock, OHVs, and other ground-disturbing activities until the site has revegetated (Clark 2001).

The effects of fire on water chemistry occur as a function of mobilization of nutrient loading from ash (Clark 2001). Primary effects would result from increased nitrogen, phosphorus, and cations. Increased ammonium nitrogen and small increases in phosphorus and nitrate levels in water are common in burned areas (Richter et al. 1982; Swanston 1991; Knoepp and Swank 1993). Burning of pinyon-juniper woodlands in southeastern Utah, for example, resulted in a 400% increase in phosphorus (Buckhouse and Gifford 1976). Nutrient levels typically "normalize" within 1 to 2 years (Clark 2001).

Use of ground-disturbing fire equipment and firelines on erosive and/or steep slopes can exacerbate erosion and sedimentation of nearby water bodies. Limiting the use of fire fighting trucks and equipment to roads or disturbed areas can reduce soil loss.

Daily temperature fluctuations in forest streams are largely regulated by the amount of solar radiation they receive (Beschta 2000). Removal of overhead vegetation along watercourses can lead to increased water temperatures after a prescribed fire. Elevated stream temperatures are detrimental to most coldwater fish species. Retaining vegetated buffers between stream courses and treatment areas, and revegetating burned areas along streams, can help to reduce effects to water temperature and stream organisms.

Effects of Mechanical Treatments

The effects of mechanical treatments on water quality would largely depend on the techniques used to remove vegetation, the proximity of the treatment site to a stream or water body, and the slope of the site. The soil disturbance associated with machinery used to remove vegetation, such as grubbing, plowing, scraping, chaining, or rutting from wheels or tracks, would increase the likelihood of soil and plant material being carried into streams by surface runoff. In addition, the compaction of soil by heavy equipment would increase the likelihood of surface runoff by reducing the soil's infiltration capacity. However, leaving debris in place after treatments would limit the negative effects on infiltration rates and sedimentation into streams (Gifford et al. 1970). There would be risks to water quality associated with the use of heavy machinery or mechanized equipment used to treat vegetation, as fuel leaks and spills could occur. Releases of fuel would be more likely to affect surface water than groundwater, and would have the greatest effects to water quality if fuel was released directly into the water.

Effects of Manual Treatments

Because manual treatments would occur over small areas (65% of treatments would be less than 100 acres), and would involve minimal soil disturbance or vegetation removal, the effects to water resources would be minimal. Manual treatment seldom results in exposed soil, and plant materials would remain in the treatment areas, minimizing the risks of sedimentation and alterations to water flow. Precautions would be

taken to minimize risks associated with the use of chainsaws or other power tools, including fuel spills.

Effects of Biological Treatments

Containment by Domestic Animals

Approximately 60% of acres treated using biological control methods would be treated using livestock, including sheep and goats. Vegetation treatments using domestic animals could affect water depending on the intensity and duration of grazing and the location of the treatment site relative to a given water body. Domestic animals can affect surface runoff as a function of trampling, soil disturbance, and soil compaction. Past studies observed that runoff from a heavily grazed watershed was 1.4 times that of a moderately grazed watershed, and 9 times greater than that of lightly grazed watershed (Rauzi and Hanson 1966). In some cases, grazing may actually improve soil infiltration by breaking up physical crusts on the soil (Walter 1984).

Livestock that graze in proximity to aquatic systems could affect water quality as a function of nutrient loading (e.g., nitrogen and phosphorous) and increase in bacterial and fecal coliforms. Cattle, for example, produce about 5 billion fecal coliforms in each feces and average 12 defecations per day, making them capable of contributing significant numbers of these organisms to surface water (Howard et al. 1983). Furthermore, the nutrients found in livestock waste stimulate algal and aquatic plant growth when deposited directly or immediately adjacent to a water body. Although this plant growth can provide a food base for aquatic organisms, an excess of nutrients can stimulate algal blooms, which reduces water quality by lowering dissolved oxygen levels. The effects of grazing treatments on water quality would depend on the number of animals, the intensity of the program, and the proximity to surface water bodies.

Biological Control Agents

Approximately 40% of acres treated using biological control methods would be treated using insects and pathogens to control vegetation. There would be minimal effects to water resources as a result of introducing insects or pathogens into treatment sites. These agents typically kill target plants slowly, after which plants remain on the site, reducing the likelihood of surface runoff and sedimentation.

Effects of Chemical Treatments

Aquatic Vegetation Control Using Herbicides

Applications of herbicides to aquatic systems would not directly modify water quantity. Indirect effects to water quantity could occur if treatments that removed unwanted aquatic vegetation reduced plant uptake of water, increasing the amount of available water.

The BLM currently uses four herbicides in riparian and aquatic habitats—2,4-D, glyphosate, imazapyr, and triclopyr—and is proposing to use diquat and fluridone in these areas, as well. The remaining herbicides available to the BLM, or proposed for use, are registered for use only on terrestrial sites.

Herbicides applied to streams, ponds, and lakes for aquatic vegetation control could affect surface water quality if applied at concentrations that exceed label requirements. Based on the HHRA (see the Human Health and Safety section and Appendix B in the PEIS), there would be low risk to drinking water in areas treated with diquat, fluridone, glyphosate, or imazapyr, even if these herbicides were accidentally spilled in streams, ponds, or lakes used by humans. However, risk is moderate to high for drinking water if treated with 2,4-D or triclopyr.

Aquatic plant control can cause a high rate of plant decomposition and may cause rapid oxygen loss from water that can seriously degrade water quality. The magnitude of this effect depends on water temperature, lake or pond stratification, and the amount and rate of plant decomposition. The effects can persist from a few weeks to an entire growing season, but are generally not permanent.

Water quality degradation could result from removal of riparian vegetation and a reduction in shade. With the loss of shade, the resulting increase in surface-water temperature fluctuations may drive water temperature beyond tolerable limits for temperature sensitive fish and other aquatic species.

Terrestrial Vegetation Control Using Herbicides

The use of herbicides to remove vegetation could affect water quantity by altering the magnitude and frequency of base flows and the magnitude of peak flows. For some treatment areas, large-scale vegetation removal could improve groundwater recharge by limiting the amount of water lost through sublimation or plant evapotranspiration. In such cases, base flow, which is

dependent on groundwater discharge, would increase. These changes could be very minor or short-lived if the vegetation did not evapotranspirate or sublimate large proportions of precipitation, or if areas were revegetated quickly (Satterlund and Adams 1992).

In contrast to increasing base flows, vegetation removal could result in the reduction of groundwater discharge and reduced base flows as a function of reduced infiltration rates. Reduced infiltration rates result in more surface runoff reaching streams and lakes immediately after a rain event, thus increasing the velocity, frequency, and magnitude of peak stream flows. These changes in water quantity could alter the physical characteristics of stream channels. Any effects would persist until the sites were revegetated, unless channel characteristics were substantially changed during this period.

The four primary means of offsite movement of herbicides are runoff, drift, misapplication/spills, and leaching. Surface water could be affected by any of these means, while groundwater potentially would be affected only by leaching.

Herbicides registered for use in terrestrial habitats may affect surface water and groundwater as a result of unintentional spills or movement of herbicides from upland sites into aquatic systems. Pollution results from herbicide concentrations that are elevated enough to impair water quality and the beneficial use of that water (USDI BLM 1991a). The potential for upland herbicide applications to reach water is affected by the herbicide's physical properties, the application method and rate, and site conditions (BPA 2000).

The vegetation, ground cover, or soil type between a treatment area and a water body can influence whether herbicides will reach water. Thick vegetation might block drift or absorb an herbicide moving through water or ground before it reaches a water body. In comparison, where little to no vegetation is present, the herbicide would encounter less resistance when washing toward the water body.

Additional effects to water quality that could occur from herbicide treatments include increased nutrient loads to surface water and groundwater. Soluble nutrients can enter surface water or groundwater. Nutrients adsorbed to particles may be moved to water bodies by wind and water erosion. Nutrient enrichment of aquatic systems can lead to algal blooms and eutrophication (mineral and organic nutrient loading and subsequent proliferation of plant life), resulting in decreased dissolved oxygen contents. The extent and duration of effects would be dependent on the geographic location, and on the extent of vegetation removal, as well as on revegetation management practices. Removal of large amounts of vegetation along streams could lead to warmer water temperatures, to the detriment of fish and other aquatic organisms.

From a watershed perspective, the concentration and amount of the herbicide applied can influence the risk of water contamination. The ratio of treated to untreated surface area in any given watershed is usually sufficiently low to permit rapid dilution. This ratio is much lower than for the concentrated areas or blocks of land typically targeted by the BLM for rangeland and forestry treatments. For example, aerial application of herbicides along a 100-foot wide ROW would result in treatment of about 2% to 3% of a 640-acre area. In contrast, treatment of 10% to 75% per 640 acres is common in forestry and rangeland applications. Risk of direct application of herbicides to streams along ROWs would increase if the linear flight path of the applicator crosses several streams.

Beneficial Effects of Treatments

Over the long term, vegetation treatments that move forests and rangelands toward historical ranges of variability, with a preponderance of native plant communities in natural mosaic patterns and relatively uninterrupted disturbance regimes, would provide favorable conditions for water quality (USDA Forest Service and USDI BLM 2000b; Hann et al. 2002). To better ensure favorable long-term conditions, the BLM proposes to increase the number of acres treated annually 3-fold, and to focus treatment efforts on high priority watersheds where state or tribal water quality standards are not met.

The proliferation of invasive and unwanted aquatic vegetation in surface waters can affect water quality, resulting in water quality degradation. Blooms of weedy vegetation can result in reduced drinking water quality, potentially limit recreation opportunities, and lead to depletion of oxygen in water, which can degrade fish and wildlife habitat. Infestations can block channels or culverts, causing flooding. Use of aquatic herbicides to remove weedy and invasive aquatic vegetation could reverse such infestations and greatly improve water quality and enhance fish and wildlife habitat and recreational opportunities. Of the two herbicides proposed for use by the BLM, fluridone demonstrates the best potential efficacy to reduce dense infestations

of aquatic plants while having few adverse effects on water quality and fish. Diquat is effective in aquatic weed control, but is a known groundwater contaminant that could harm native fish and plants. Its use should be limited to areas where vegetation control is paramount and risks to fish and water quality are of less concern.

Historical fire suppression may have affected water quality and quantity. On rangelands, fire suppression is partly responsible for the spread of pinyon-juniper woodlands. The spread of western juniper and increase in the density of juniper stands could lead to conditions that favor decreased soil infiltration and increase in peak discharges. Fire suppression in forests has led to increased aboveground vegetation that may contribute to increased evapotranspiration rates and decreased runoff. Where high severity fires have increased due to fire suppression, soil porosity has decreased and led to increasing soil erosion and runoff. Efforts to reduce the risk of catastrophic wildfires would reduce the potential for excessive loss of plant and litter cover and the potential for soil erosion and mass failures that cause a decrease in water quality. Fire use and other treatments that restore natural fire regimes and ecosystem processes would reduce the effects of fire suppression and benefit water resources and quality, especially in high priority watersheds, in Fire Regime Condition Class 3 areas, and in areas dominated by downy brome and other invasive species.

Mechanical and other methods to control pinyon-juniper have been used in attempts to increase water yield and groundwater recharge. Chaining and windrowing debris from pinyon-juniper woodlands may reduce infiltration and increase streamflow, while double-chaining and leaving debris in place may not affect infiltration and water yield (Williams et al. 1972; USDI BLM 1991a). Creation of large depressions in the soil during treatments could reduce runoff and increase infiltration by storing water (Richardson et al. 1979). Rootplowing of creosote bush sites in Subtropical Steppe rangelands reduced runoff by increasing surface roughness and water storage, but rootplowing of creosote bush and seeding grass in New Mexico resulted in less vegetative cover and lower infiltration rates than in untreated areas (Tromble 1980). Infiltration rates increased on rootplowed areas when seeded grass cover had sufficient time to increase.

Herbicide use can benefit water quality if vegetation removal reduces the risk of catastrophic fire. Treatment of upland areas to reduce fuel loading could contribute to long-term benefits to surface water quality by reducing the risk high-intensity wildfires. In addition, the use of herbicides to control invasive species in terrestrial and aquatic systems could provide long-term benefits to water quality with the return of more stable soils, attenuated nutrient cycling, and return to normal fire cycles.

Approximately 10% of treatment acres could be treated using new herbicides proposed for use in the PEIS, and the BLM could use additional new herbicides in the future. Diquat and fluridone could be directly applied in aquatic systems to control unwanted submersed aquatic vegetation. Approval of diquat and fluridone would provide new capabilities for controlling invasive aquatic plants and could provide benefits to water quality if invasive aquatic plants were eliminated. Fluridone, in particular, has been effective at controlling Eurasian watermilfoil without resulting in effects to drinking water quality or recreation (Washington Department of Ecology 2003). Imazapic is not known to contaminate groundwater and would be used to control downy brome infestations. Diflufenzopyr is not known to contaminate groundwater, but has a high potential to leach to groundwater. Except for fluridone, which has a high potential for surface water runoff, the proposed herbicides have low potential to flow to aquatic bodies in stormwater runoff.

Much of the effort by the BLM to reduce salinity levels in the Colorado River Basin is focused on minimizing surface disturbance and revegetating disturbed sites in soils with a high natural content of salt. Controlling salinity in rangeland surface runoff is closely related to controlling soil erosion. Vegetation cover is usually the most important management variable influencing runoff and erosion rates on rangelands. In systematically targeted watersheds, the payoff for salinity control is that decreased sediment yields and moderated flood flow energies should combine to transport less salt from the uplands, as well as from gullies and established channels.

The Forest Service and BLM used modeling to predict the effects of an aggressive program of treating vegetation and controlling land disturbances, similar to those proposed in this PER, on water resources and quality in the Interior Columbia Basin. Although few benefits would be expected during the first 10 years after treatment, long-term benefits included reduced rates of soil erosion and improvement in other water quality parameters. Implementation of restoration activities, including restoring natural fire regimes, restoring native grasses, forbs, and shrubs, managing land uses to reduce the extent of exotic plant invasions,

and focusing treatments in high priority watersheds, would result in the greatest benefits.

Wetlands and Riparian Areas

The BLM manages over 23 million acres classified as riparian or wetland. Wetlands and riparian areas in the western U.S. and Alaska are influenced by human activity, natural disturbance, and local physical and biological conditions. Invasive plant species degrade wetland and riparian area function and present a challenge to vegetation management. An estimated 59,000 acres of wetland habitat and 17,500 stream miles on BLM lands lack characteristics necessary for "high" functioning wetland and riparian habitats (USDI BLM 2006d). Invasive plant species are one factor that degrades wetland and riparian function. Hazardous fuels buildup can lead to catastrophic wildfires that can also adversely affect wetland and riparian habitat.

Wetlands and\ riparian areas provide important ecological functions, including flood water attenuation, sediment trapping, and nutrient transformation and retention (Westbrooks 1998). In addition to physically displacing native vegetation, invasive plant species and wildfires can alter the fire frequency, hydrologic properties, soil chemistry, and physical structure of wetland and riparian ecosystems.

Invasive plants often spread quickly over large areas, displacing native vegetation and habitat for wildlife. Invasive plants outcompete native species because they have no natural predators to limit their reproduction and spread (Westbrooks 1998). Thus, removal of non-native and invasive plants would be expected to result in an improvement in the environmental health of wetland and riparian ecosystems.

Vegetation treatments would benefit wetland communities by decreasing the growth, seed production, and competitiveness of target plants, thereby releasing native species from competitive pressures and aiding in their reestablishment. The degree of benefit would depend on the success of the treatments over both the short and long term. Some treatments that are successful at removing weeds over the short term may not accommodate the establishment of native species. In such cases, seeding of native plant species would be beneficial.

Scoping Comments and Other Issues Evaluated in Assessment

Comments were received concerning water quality and water issues and the potential for increased infiltration, reduced runoff and erosion, and sediment transportation within wetlands and riparian areas from vegetation treatments. Concern was also expressed regarding the effect of grazing in riparian areas. Recommendations were made to scale back fuels reduction in riparian areas and to suppress fires near rivers.

Resource Program Goals

The Soil, Water, and Air Management and Riparian Management programs are primarily responsible for activities that affect wetlands and riparian areas. Wetland and riparian areas comprise only about 9% of public lands, but support some of the most ecologically diverse and important plant and animal communities occurring on public lands (USDI BLM 2006c).

Treatments would be focused on watersheds that fail to meet resource objectives and/or that provide habitat for greater sage-grouse. The BLM would also initiate restoration efforts in wetland and riparian areas in less than proper functioning condition, with much of the emphasis on controlling invasive and noxious weeds (USDI BLM 2006c). The BLM has ongoing programs to control invasive vegetation and noxious weeds in riparian areas, including saltcedar. The BLM is working with Ducks Unlimited and other groups to create wetlands and improve stream habitat. Substantial effort is focused on removing and revegetating abandoned logging roads to reduce erosion and sedimentation of nearby aquatic bodies, and to restore habitat for salmon and other fish in the Columbia River Basin (USDI BLM 2006c).

Fire exclusion policies, buildup in hazardous fuel levels, and increase in acreage dominated by invasive vegetation have led to more frequent fires of greater severity and duration and increased soil erosion over many areas of the West. These conditions have often led to deterioration in wetland and riparian habitat in affected areas (USDA Forest Service and USDI BLM 2000b). Although disturbances from fire, wind, plant disease, grazing by wildlife, floods, and other factors will always be important in shaping ecosystems in the western U.S., efforts by the BLM to restore wetland and riparian vegetation to more natural conditions, and to reduce fuels buildup and the frequency of catastrophic

fires, should lead to a slow improvement in wetland and riparian habitat in treated areas.

Standard Operating Procedures

This assessment of effects assumes that SOPs (listed in Table 2-5) would be used to reduce potential unintended effects to riparian and wetland areas. Prevention and early detection is the least costly and most effective weed control method. Weeds colonize highly disturbed ground and invade plant communities that have been degraded, but are also capable of invading intact communities.

Reseeding or replanting may be required to revegetate sites in which the soil has been disturbed or vegetation has been removed, and where there is insufficient vegetation or seed stores to naturally revegetate the site. Disturbed riparian and wetland areas may be reseeded or planted with desirable vegetation when the native plant community cannot recover and occupy the site sufficiently. The goal of revegetation is to stabilize and restore vegetation on a disturbed site and to eliminate or reduce the conditions that favor invasive species. Plant materials that are brought onto public lands should be free of disease. Chances for revegetation success are improved by selecting seeds with high purity and percentage germination; selecting species native or adapted to the area; planting at proper depth, seeding rate, and time of the year for the region; choosing the appropriate planting method; and, where feasible, removing competing vegetation. Planting mixtures are adapted for the treatment area and site uses. For example, a combination of shrubs and trees might be favored for riparian sites.

For application of herbicides not labeled for aquatic use, the BLM would specify herbicide-free buffer zones based on risk assessment guidance, with minimum widths of 100 feet for aerial, 25 feet for vehicle, and 10 feet for hand spray applications. Buffers would reduce the potential for transport of terrestrial herbicides into wetland and riparian habitats. Operational plans should also include information on project specifications, key personnel responsibilities, communication procedures, safety, spill response, and emergency procedures. Additional SOPs for herbicide treatments may be found in Table 2-8 of the PEIS.

Adverse Effects of Treatments

Approximately 30,000 acres of wetland and riparian habitat would be treated annually. Of these acres, approximately 34% would be treated using chemical treatments, 30% using biological control methods, 28% using mechanical and manual methods, and 8% using fire. Herbicide treatments would be conducted using ground-based equipment, and over 80% of treatments would occur in the Temperate Desert and Subtropical Steppe ecoregions. Biological control treatments would primarily involve the use of insects. Although there are no current plans to use prescribed grazing to contain vegetation in riparian or wetland habitat, based on information provided by BLM field offices, there is at least some potential to use livestock grazing as a biological control in these habitats. The use of livestock to control vegetation in riparian and wetland habitats would require very careful planning and execution to avoid impacts to other resources. In these habitats the timing, amount, and duration of grazing would be very specifically designed to impact the growth and reproduction of target plant species without inhibiting the ability of native vegetation to reproduce and revegetate the treatment area. Although prescribed grazing may not be an effective tool in many riparian and wetland habitats, it may be useful in some situations and should therefore be considered. Nearly all fire treatments in riparian areas would be 100 acres or less. An increase in soil erosion and surface water runoff could result from vegetation removal, which could lead to streambank erosion and sedimentation in wetlands and riparian areas (Ott 2000). Rates of runoff would be influenced by precipitation, rate of vegetation recovery, soil types, and proximity to the treated area. All vegetation removal activities could disturb the soil and reduce the amount of vegetation that can bind to soil, potentially causing erosion and increased sedimentation of wetlands and riparian areas. Sediments can affect plants within wetlands and riparian areas by reducing the amount of sunlight reaching plants and slowing or stopping plant growth.

The removal of vegetation would decrease the amount of rainfall captured by plants, detritus, and soil, potentially leading to increased stormwater flows and runoff velocity in both ecosystems. Increased stormwater runoff can scour wetlands and modify their morphology, and affect the distribution and abundance of aquatic organisms within the area. Many species that use wetlands have evolved life-history strategies that depend on stable conditions (i.e., stable water quality and quantity). For example, vegetation removal resulting in increased water flows to wetlands during the spring could flood the breeding sites of aquatic organisms that breed or lay eggs in moist soil, harming or killing eggs or juveniles.

A reduction in non-target aquatic vegetation can result in oxygen depletion as the vegetation begins to decompose. Siltation of wetlands could reduce water quality and the amount of oxygen available to aquatic organisms. In addition, siltation could reduce the acreage of wetland and riparian habitat.

Effects of Fire Treatments

Only about 2,300 acres of wetland and riparian habitat would be treated annually using fire, the smallest acreage of all the treatment methods, and only 0.1% of all acres would be treated using fire. The effect of fire on wetland and riparian areas would depend on the natural fire regime of the area, the time of year the fire occurred, and the extent of the fire. Fires can also consume or degrade peat soil, change the vegetation composition and structure of an area, and increase erosion and turbidity in wetlands. In general, prescribed fires would have fewer impacts than wildfires, as they are low severity and can be controlled to occur in one particular area.

Because of the high productivity of wetlands, and the density at which many wetland species occur (e.g., phragmites, cordgrass, cattail, and reed canarygrass), fuel loads are often considerably higher per unit area in wetlands than in uplands. In riparian areas where vegetation density is high, the potential for hotter, more extensive burns is elevated (Thompson and Shay 1984). High intensity fires could also kill large trees, with increases in stream flow and erosion as a result of vegetation loss.

Replacement of native vegetation by exotic plant species, many of which are highly flammable, can contribute to an increased incidence of fire in riparian areas. Tamarisk, giant reed, and annual grasses such as red brome all are highly flammable. The spread of many of these exotics is due in part to the same changes in stream flow regimes that render the riparian areas more susceptible to fire.

Fire intensity, magnitude, and behavior vary with the composition, density, and structure of local vegetation, litter depth, fuel loading and moisture content, soil composition, water table, and climate (Rassman 1993 *cited in* Culver 1997). As a result, fire may lightly char or slowly burn an area or may burn rapidly, resulting in crown-destroying burns, depending on the combination of these variables and site conditions (Berndt 1971; Minshall et al. 1989; Rassman 1993 *cited in* Culver 1997).

Effects of Mechanical Treatments

Mechanical treatments would occur on approximately 3,500 acres of wetland and riparian habitat annually, or about 0.2% of all acres treated using mechanical methods. Treatments would involve mowing, disking, and chopping. The effects of mechanical treatments on wetland and riparian areas would be related to the types and amounts of soil disturbance and vegetation removal, the proximity of the treatment to a wetland or riparian area, and the incidence of accidental spill.

Methods for controlling aquatic vegetation include harvesting aquatic plants using machines that can cut the plant in an area 6 to 20 feet wide and from 5 to 10 feet below the water surface. These harvesters can "open" up an area, but can also lead to the spread of aquatic vegetation to new areas. In addition, harvesters may affect fish and other aquatic organisms by removing them in harvested material. Cutting plant stems too close to the bottom can result in resuspension of bottom sediments and nutrients (Madsen and Stewart 2004).

Weed rollers, which can be up to 30 feet long, compress the sediment and plants in an area. Frequent use of rollers allows only limited growth of vegetation, and may disturb bottom-dwelling organisms and spawning fish. A rotovator is similar to an underwater rototiller. The equipment dislodges and removes plants and roots. Since the rotovator greatly disturbs the bottom sediments, there is concern that use of the equipment can: 1) resuspend contaminated sediments; 2) release nutrients absorbed or precipitated in the sediment (e.g., phosphorus); 3) adversely affect benthic organisms; or 4) affect fish spawning areas.

Blading, tilling, and grubbing disturb soil and can increase erosion, and thus may degrade aquatic habitat, especially when the treatment is performed on hillslopes. Erosion can be a problem on slopes greater than 20%. Thus, such mechanical methods should be avoided on steep hillslopes. To reduce effects, the BLM would limit blading to relatively level areas, and would reseed bladed and grubbed sites to prevent runoff and erosion.

Chaining, roller chopping, and mowing that mulches plant debris can aid in erosion control. Retention of a vegetated buffer between the treatment area and water could also reduce the risk of sedimentation and stabilize soils within an area. Emergent plants, such as cattail, common reed, whitetop, and sedge, that are mowed as close as possible to the substrate to facilitate inundation

of the stubble during the growing season, can be effective in reducing shoot density by 50% or more (Kaminski et al. 1985). Dense stands of cattail and or other emergents can be controlled by burning during winter, shredding the remaining stubble, and then flooding the cut stalks for at least 2 weeks (Weller 1975, Murkin and Ward 1980).

The use of heavy equipment can result in soil compaction, particularly in areas of moist soils that can increase surface runoff from the surrounding treated areas. Compaction by vehicles and other heavy equipment can reduce the porosity of soils, thus limiting water infiltration. The magnitude of effects to wetlands would depend on soil compaction and weather. One means to minimize the effect of heavy equipment on soil involves the use of tracked or low-pressure tires, which distribute vehicle weight over a larger area, thus reducing pressure on soil. Treatment by mechanical methods during dry months can also minimize the effects to wetlands by reducing the potential for surface water runoff into wetlands.

Spills resulting from fueling, equipment maintenance, and operation could adversely affect water quality and the health of wetland or riparian areas. These risks would be minimized by having provisions for incident response in the SOPs.

Effects of Manual Treatments

Manual treatments, which can target smaller areas, would be less likely to affect wetland and riparian areas than the other methods. Manual treatments would occur on approximately 4,400 acres of wetland and riparian habitat. Over 50% of the acres treated would be in Nevada. Treatments would involve the use of chainsaws and seeding or planting.

Hand treatments would remove the overstory and would cause little soil disturbance or erosion. In most cases, unwanted vegetation near a wetland or riparian area could be removed without disturbing more desirable species. Typically, plant debris would be mulched and left on site. Fuel and lubricant spills that could result from using chainsaws and trimmers would be contained or cleaned up before contamination spread to surrounding sensitive areas.

Effects of Biological Treatments

Approximately 9,400 acres of wetland and riparian habitat would be treated using biological control methods. Nearly all acres would be treated using insects. Most of the acres treated would occur in the Temperate Steppe Ecoregion.

Containment by Domestic Animals

Although most biological control in wetlands and riparian areas would be accomplished using insects, there could be some use of livestock. The degree of effect to wetlands and riparian areas from treatments using domestic animals would be dependent on the timing, duration, and intensity of grazing. Direct effects could include stream channel/wetland morphology alteration, and loss of native wetland or riparian vegetation. Improper grazing management can have a considerable effect on vegetation vigor and biomass, and species diversity (Kauffman and Krueger 1984). The potential loss of vegetation as a function of improper grazing management can lead to further loss of aquatic habitat as channels widen and water depths become shallower (Hubert et al. 1985; Platts and Nelson 1985; but see George et al. 2002). These potential impacts highlight the need for very carefully planned prescribed grazing which would require control of the timing, amount, and duration of grazing to limit these potential impacts. Temporary electric fencing, short term use of a pasture, preconditioning livestock to encourage grazing of the targeted vegetation, and herding are examples of measures that could be taken to minimize impacts.

Biological Control Agents

In most cases, these biological treatments would involve the release of organisms intended to weaken or kill vegetation. Vegetation would remain in place, resulting in little soil disturbance in the treatment area. If treated successfully, the plant community near or within the wetland or riparian area should improve.

Effects of Chemical Treatments

Approximately 10,000 acres of wetland and riparian habitat would be treated annually using herbicides. Herbicides may directly or indirectly affect the survival, health, or reproduction of non-target wetland or riparian plants or may affect characteristics of these plant communities and their ecosystem functions. Additionally, aquatic system herbicides are not species-specific, and the use of these herbicides may result in direct and indirect effects on wetland and riparian species diversity, competitive interactions, species dominance, and vegetation distribution (Kleijn and Snoeijing 1997). Herbicide applications could reduce plant cover leading to increased sedimentation,

increased nutrient loading, alterations in native vegetation, and changes to temperature and hydrologic conditions. The effect of an herbicide's damage to non-target plants and the surrounding ecosystem can be evaluated by looking at its effects on 1) species diversity, 2) functionality of the wetland or riparian area in terms of wildlife habitat, recreational use, or groundwater recharge, 3) forest product (e.g., timber, wood pulp) production, and 4) aspects affecting environmental quality (e.g., soil erosion, invasion of noxious weeds, creation of vegetative barriers; Obrigawitch et. al 1998).

An increase in soil erosion and surface water runoff could result from vegetation reduction near riparian and wetland areas, which could lead to streambank erosion and sedimentation (Ott 2000). The amount and likelihood of streambank erosion and sedimentation would be directly proportional to the size of the treatment area (i.e., larger treatment areas would have increased risk of streambank erosion and sedimentation). Additionally, sedimentation could result in a reduction in the acres of wetland and riparian habitat.

Risks to wetland and riparian non-target species would depend on a number of factors, including the amount, selectivity, and persistence of the herbicide used; the application method used; the timing of the application; and the plant species present. Risks to wetlands and riparian areas from surface runoff would be influenced by precipitation rates, soil types, and proximity to the application area. Some herbicides (e.g., sulfometuron methyl) that adsorb into soil particles could be carried off-site, increasing their risk of affecting vegetation in wetlands and riparian areas.

Unintentional applications could have severe negative effects for wetlands and riparian systems. In particular, accidental spills near wetland and riparian areas could be particularly damaging to wetland and riparian vegetation. Spray drift can also degrade water quality in wetlands and riparian areas and could damage non-target vegetation.

Beneficial Effects of Treatments

Successful control of invasive plants in wetlands and riparian areas would lead to improved conditions in these habitats over the long term. The eventual growth of desirable vegetation in treated areas would moderate water temperatures, buffer the input of sediment and herbicides from runoff, and promote bank stability in riparian areas. Ongoing efforts by the BLM to enhance wetland and riparian vegetation would also help to increase the number of miles of stream and acres of wetlands that are in proper functioning condition. Improvement of riparian and wetland habitat would also benefit salmonids and other species of concern that depend on these habitats for their survival (USDA Forest Service and USDI BLM 2000b).

Control of aquatic and riparian vegetation can improve habitat quality for fish and wildlife, improve hydrologic function, and reduce soil erosion. Much of the BLM's vegetation control efforts in wetlands and riparian areas would focus on non-native species that can substantially alter wetland and riparian habitats, such as purple loosestrife, water-thyme, and Eurasian watermilfoil. Purple loosestrife forms extensive monotypic stands that displace native vegetation used by wetland animal species for food and cover (Bossard et al. 2000). Purple loosestrife can also alter the hydrology and soil conditions of wetland pastures and affect recreational activities. Water-thyme is an aquatic species that forms large mats that fill the water column and can severely restrict water flow, leading to a decrease in habitat for fish and wildlife and degraded water quality. Eurasian watermilfoil is another aquatic species that has spread across the West and that has been found to alter the physical and chemical characteristics of lakes and streams.

Vegetation treatments that reduce hazardous fuels would benefit wetlands and riparian areas by reducing the potential for catastrophic wildfires and resultant loss of high quality wetland and riparian habitat. Hazardous fuels reduction would also decrease the likelihood that wildfire suppression activities would occur in or near aquatic habitats.

Effects of Fire Treatments

Fires in wetlands or riparian areas can have both a positive and negative effect on the ecosystem. In addition to restoring conditions that more closely resemble those that would occur under natural fire conditions, prescribed fire may decrease hazardous fuels, trigger germination of some plant species, stimulate growth of new vegetation, and open up and create new habitat for wildlife (Agee 1994, Brennan and Hermann 1994, Payne and Bryant 1998). By removing vegetative debris, cover burns temporarily release more desirable plants that have an earlier growing season than more objectionable plants, such as cordgrass. Peat burns made during a drought can convert a marsh into aquatic habitat (Payne and Bryant 1998).

Fire may provide indirect benefits to wetlands by raising the pH of soil in certain areas. Since nutrient availability is related to soil acidity, elements critical for plant growth, such as phosphorus and nitrogen, become more available to plants as the soil pH increases. Fire also helps to release nutrients that may be tied up in forms that are unavailable to plants, such as woody material. The burning of surface organic matter releases some nutrients onto the soil in the form of ash, resulting in increased calcium, phosphorus, and potassium. This influx of nutrients could contribute to vegetation growth (DeBano et al. 1998).

Fires that kill trees create a source of standing wood that ultimately provides fish habitat. The input of woody debris can continue for a year or more after a burn (Young 1994; Minshall et al. 1997; Berg et al. 2002). Large wood in streams and wetlands provides hydraulic roughness, serves as a food source for aquatic and wildlife species, and provides habitat for wildlife. Conversely, devastating fires that result in fewer trees on a site would limit the input of woody debris to aquatic systems.

Prescribed fire or low intensity fires would be more likely to kill shrubs and deciduous trees than larger conifers. Since many species of shrubs and trees resprout, soil stability should not be impaired and conifers could continue to serve as a source of wood to aquatic habitats. For a comprehensive treatment of a site, however, prescribed fire may be followed by additional treatment. For example, burning followed by mechanical treatment has proven to be a successful treatment for invasive vegetation such as saltcedar (Ball et al. 2001).

Effects of Mechanical and Manual Treatments

Mechanical methods are appropriate for vegetation treatments near water where a high degree of control is necessary to reduce the risk to aquatic habitats from the use of fire and herbicides. Manual treatments, which tend to be more selective and involve smaller treatment areas than other methods, would be less likely to affect wetland and riparian areas than the other methods. Stump cutting and application of Arsenal® has been effective in control of saltcedar. Saltcedar topgrowth should not be removed for 3 years following herbicide application or resprouting will occur (Lym 2002).

Effects of Biological Control Treatments

With proper management, grazing can result in desirable plant response from riparian vegetation. Seasonal exclusion of cattle is effective in minimizing effects to soil and vegetation. With the right timing and amount of grazing pressure, invasive plants such as reed canarygrass, river bullrush, and cattail can be effectively controlled. The extensive root systems of these species are shredded by the cow's hooves. Studies have shown that rest-rotation and/or specialized grazing management of riparian zones as special use pastures is successful (Kauffman and Krueger 1984). For example, Davis (1982 *cited in* Kauffman and Krueger 1984) in Arizona found that a four-pasture rest-rotation system was a cost-effective and successful method for rehabilitating riparian areas when each pasture received spring/summer rest for 2 years out of 3.

Brush and weed management through grazing can benefit riparian areas. Goats and sheep have long been used for weed control. Goats are often used to control weeds and non-native brush species in riparian areas. Grazing allows for the release of more desirable plants, contributing to improved riparian and wetland conditions (Luginbuhl et al. 2000; Pittroff 2001). For example, the use of goats in areas infested with leafy spurge has proven successful. Goats show a strong preference for spurge and are less costly to use than chemical control measures.

Insects have been used effectively for biological control. For example, *Diorhabda elongata deserticola*, a leaf beetle from central Asia, has been used as a biological control agent for saltcedar. This insect can defoliate large areas of saltcedar (USDA 2003).

Several insects feed upon purple loosestrife, including the black-margined loosestrife beetle, golden loosestrife beetle, loosestrife root weevil, and blunt loosestrife seed weevil. These insects feed upon the exposed shoots during early spring. The golden loosestrife beetle was found to reduce flowering spike density by over 80% at two sites in Oregon. The loosestrife root weevil larvae feed on the roots of purple loosestrife, while the adults feed upon the foliage. The blunt loosestrife seed weevil feeds on leaves and immature seed capsules, while larvae eat the developing seeds within the capsules. Larvae destroy about 50% of the seeds within the capsules they infest (Rees et al. 1996).

The salvinia weevil has been shown to be an extremely effective biological control agent for giant salvinia. This highly specific insect feeds only on salvinia species from South America, rejecting closely related species from Africa and Europe. Biomass declined from more than 100 tons of fresh weight salvinia per acre at some sites in Louisiana and Texas to less than 2 tons during

the same period. At two sites, one each in Texas and Louisiana, the mats of giant salvinia have almost completely collapsed. These waterbodies formerly choked with the weed are now mostly open water (USDA ARS 2004).

Effects of Herbicide Treatments

The BLM's ability to use four new chemicals (fluridone and diquat for aquatic applications, and imazapic and Overdrive® for terrestrial applications), and new herbicides as they would become available and approved for use, would provide new capabilities to the BLM for controlling problematic invasive species and would provide benefits to these wetland and riparian areas if invasive species were controlled or eliminated.

Risks to wetland and riparian areas from use of these herbicides are similar to or lower than for risks associated with currently-approved herbicides. The risks to wetland and riparian plants from accidental spill and drift scenarios would be lower with the proposed herbicides than with currently-approved herbicides. In addition, fluridone is specifically indicated for aquatic use, whereas none of the other currently-approved herbicides are strictly aquatic herbicides. Under the other herbicide treatment alternatives, diquat and fluridone would be used to treat aquatic vegetation, and both have shown to be effective in the control of Eurasian watermilfoil, water-thyme, water hyacinth, and giant salvinia. The other herbicides registered for aquatic use, glyphosate and triclopyr, are not as effective in controlling these species. However, disking with a follow-up spraying of Rodeo® (formulation of glyphosate), was effective in treating reed canarygrass in Washington State wetlands (Killbride and Paveglio 1999, Paveglio and Killbride 2000)

Overdrive® and imazapic would primarily be used on rangelands, but could still provide benefits. Overdrive® would be used to treat thistles and knapweeds, while imazapic could be used to control downy brome. These invasive plant species degrade riparian habitats and can lead to shortened fire cycles, followed by soil erosion and sedimentation.

The BLM does not propose to use herbicides in Alaska, where the majority of the wetland and riparian areas on BLM lands are found. However, the BLM would retain the option to use herbicides in Alaska should the need arise and the benefits of using herbicides outweigh the risks of other treatment methods.

Vegetation

The present-day composition and distribution of plant communities in the western U.S. are influenced by many factors, including physical factors (e.g., climate, drought, wind, geology, topography, elevation, latitude, slope, exposure) and natural disturbance and human-management patterns (e.g., insects, disease, fire, cultivation, domestic livestock grazing, wildlife browsing; Gruell 1983). In addition, competition with invasive plant species has resulted in the loss of some native plant communities in the western U.S. The rapid expansion of invasive plant species across public lands continues to be a primary cause of ecosystem degradation, and control of these species is one of the greatest challenges in ecosystem management. The recent increase in wildfires has been influenced by changes in vegetation on public lands over the past 100 years, which have resulted in increases in hazardous flammable fuels.

Scoping Comments and Other Issues Evaluated in Assessment

The largest number of comments submitted pertained to vegetation. Numerous scoping comments were centered around a desire for the BLM to focus on long-term ecosystem sustainability and biological diversity. Numerous comments suggested that the PEIS and PER address all invasive plants, not just weeds. One respondent proposed focusing on minimizing the spread of existing weed infestations, while others wanted to ensure that weed control measures do not result in more ecological disturbances than the weeds themselves. A large number of comments recommended evaluating the effect of herbicides on other plant and animal species within the areas considered for treatment. Several comments called for the PEIS to address the effects of new-generation, high-potency herbicides on non-target plants. There was some concern about weeds becoming resistant to herbicides, and how the BLM would prevent the death of beneficial native plants from herbicides. To improve greater sage-grouse habitat, one respondent recommended that instead of burning sagebrush, strips of vegetation should be treated with herbicides, then cattle allowed to break the vegetation down, followed by planting with grass.

Resource Program Goals

The goals of vegetation management are to manage vegetation to sustain the condition of healthy lands, and,

where land conditions have degraded, to restore desirable vegetation to more healthy conditions. Eventually, the number of acres needing treatment should be reduced as a result of overall improvement in conditions.

To achieve these goals, the BLM must 1) understand and plan for the condition and use of public lands, 2) focus on restoring those sites that would most benefit from treatments, 3) select the appropriate treatments and SOPs to improve the likelihood of restoration success, 4) monitor treatments to better understand what works and what does not work, and 5) convey information about treatment activities to BLM staff and the public.

Concurrently, public lands must be administered under the principles of multiple use and sustained yield in accordance with the intent of Congress as stated in the FLPMA. Thus, vegetation must be managed to protect and enhance the health of the land while providing a source of food, timber, and fiber for domestic needs (USDI BLM 2000c). Land-disturbing activities must be conducted in a manner that minimizes ecosystem fragmentation and degradation, and lands should be rehabilitated when necessary to safeguard the long-term diversity and integrity of the land.

A discussion of individual BLM vegetation treatment programs and their responsibilities is in Chapter 2, Vegetation Treatment Programs, Policies, and Methods.

Standard Operating Procedures

This assessment of treatment effects assumes that SOPs listed in Table 2-5 would be used to reduce potential unintended effects to non-target vegetation. For all treatment methods, the BLM would identify and implement any temporary domestic livestock grazing and/or supplemental feeding restrictions needed to enhance the recovery of desirable vegetation following treatment, and consider adjustments in the existing grazing permit (including the application of state or regional grazing administration guidelines) needed to maintain recovery of desirable vegetation following treatment.

For fire use, the BLM would keep fires as small as possible to meet the treatment objectives, conduct low intensity burns to minimize adverse impacts to large vegetation, limit the area cleared for fire breaks and clearings to reduce the potential for weed infestations, and use mechanical treatments to prepare forests for the reintroduction of fire, where appropriate.

For mechanical and manual treatments, the BLM would remove damaged trees and treat woody residue to limit subsequent mortality by bark beetles. For mechanical treatments, workers would power wash vehicles and equipment to prevent the introduction and spread of weed and exotic species. For chaining activities, the BLM would use lighter chains with 40- to 60-pound links where the objective is to minimize disturbance to the understory species; avoid chaining in areas where annual rainfall is less than 6 to 9 inches, especially if downy brome is present; and use two chainings to reduce tree competition and prepare the seedbed, as appropriate. The second chaining would be carried out at the most advantageous time for seeding.

For biological control treatments, domestic animals would be used at the time they are most likely to damage invasive species, and animals would be managed to prevent overgrazing and to minimize damage to sensitive areas. For herbicide treatments, SOPs include using drift reduction agents, using the appropriate application rate to treat weeds and other noxious vegetation to minimize effects to non-target vegetation, and conducting pre-treatment surveys for sensitive habitat and species of concern.

Prevention and early detection are the least costly and most effective weed control methods. Weeds colonize highly disturbed ground and invade plant communities that have been degraded, but are also capable of invading intact communities. Passive treatments, such as removing the cause of disturbance (e.g., livestock, OHVs) may be more effective over the long term than active treatments, and would be evaluated for their merit before implementing active treatments.

Reseeding or replanting may be required to revegetate sites in which the soil has been disturbed or vegetation has been removed, and where there is insufficient vegetation or seed stores to naturally revegetate the site. Disturbed areas may be reseeded or planted with desirable vegetation when the native plant community cannot recover and occupy the site sufficiently. The goal of revegetation is to stabilize and restore vegetation on a disturbed site and to eliminate or reduce the conditions that favor invasive species. Plant materials that are brought onto public lands should be free of weeds and disease. Chances for revegetation success are improved by selecting seeds with high purity and percentage germination; selecting species native or adapted to the area; planting at proper depth, seeding rate, and time of the year for the region; choosing the appropriate planting method; and, where feasible, removing competing vegetation. Planting mixtures are

adapted for the treatment area and site uses. For example, a combination of shrubs and trees might be favored for riparian sites.

These procedures would help minimize effects on plants to the extent practical. As a result, long-term benefits to natural communities from the control of invasive species would likely outweigh any short-term negative effects to non-target plants associated with treatments.

Adverse Effects of Treatments

Some vegetation treatments would cause disturbances to plant communities by killing both target and non-target plants, while others would improve the vigor and health of plants (e.g., seedings and plantings and treatments that "release" more desirable vegetation). The extent of these disturbances would vary by the extent and type of treatment, as discussed in the sections that follow. In many cases, the treatments would return all or a portion of the treated area to an early successional stage, killing off disturbance intolerant species, such as sagebrush, and freeing up resources such as light and nutrients for early successional species, such as perennial grasses and forbs. In areas where fire suppression has historically occurred, vegetation treatments would be expected to benefit native plant communities by mimicking a natural disturbance component that has been missing from these communities, altering them over time. In areas that have been highly degraded, merely restoring disturbance to the ecosystem may in some cases adversely affect native plant communities because many of the desired native species are no longer present, and treatments can result in the spread of weeds or the persistence of an altered vegetation structure and species composition. These effects, which would vary depending on the treatment used, the type of vegetation on the treatment site, the amount of degradation on the site, as well as numerous other factors, are discussed in more detail by treatment type, ecoregion, and vegetation type in the sections that follow.

Approximately 2.2 million acres would be treated annually using mechanical methods, and 2.1 million acres using fire. The remaining treatments would involve chemical (932,000), biological control (545,000) and manual (270,000) methods. Most treatments would occur in the Temperate Desert (50% of all treatments), Temperate Steppe (28%), and Mediterranean (8%) ecoregions. Fewest treatments would occur in the Subtropical Desert (1%) and Marine (2%) ecoregions. Over 40% of treatments would occur in the evergreen shrubland (31% of all treatments) and evergreen woodland (12%) plant communities. Twenty-two percent of treatments would involve multiple plant communities (e.g., evergreen shrubland and riparian).

Effects of Fire Treatments

Fire treatments would injure and kill plants, causing the most harm to species that are intolerant of fire, and in most cases benefiting fire-adapted or fire-dependent species. Fire would also stimulate the growth of certain plants, such as grasses and aspen. Many woody species would be top-killed by fire. Forbs, grasses, shrubs, and deciduous trees that have the capacity to resprout would be capable of recovering quickly. Some species readily reproduce from seed. Established perennial plants that can recover vegetatively would typically have a short-term competitive advantage over plants developing from seed because their well-developed root systems and stored energy reserves support rapid regrowth. Plants with growing points near the surface (e.g., black grama) or dense growth at their base that concentrates heat (e.g., bluegrasses, Idaho fescue, and needle-and-thread grass) are more likely to be negatively affected by fire (Paysen et al. 2000). Plants with their growing points protected by soil, such as perennial forbs and shrubs with deep roots, would generally respond more favorably to burning. Tables 4-5 through 4-8 show the effects of fire on representative invasive species and the ability of native trees and brush to regenerate after fire.

Approximately 63% of fire treatments would occur in the Temperate Desert Ecoregion, and 12% and 9% would occur in the Subarctic and Subtropical Steppe ecoregions, respectively. Nearly half (48%) of treatments would occur in evergreen shrublands and 19% would occur in evergreen woodlands. Six percent of treatments would occur in evergreen forest and perennial graminoid communities (Table 4-9).

Fire Effects by Ecoregion

Tundra Ecoregion. Fire use is not planned for the Tundra Ecoregion. If fire was used, it would likely consist of wildland fire use for resource benefit. As stated in the *Alaska Interagency Wildland Fire Management Plan* (Alaska Wildland Fire Coordinating Group 1998), "lightning caused wildland fires are an important component of the boreal forest and arctic tundra ecosystems, and the complete exclusion of these fires is neither ecologically sound nor economically feasible."

Tundra environments are fire-dependent ecosystems that have evolved in association with fire and lose their

vigor and floral diversity if fire is excluded. Fire may be the chief factor maintaining productivity in cold Alaska soils, where most nutrients are tied up in the vegetative overstory, and in the thick moss and organic layers, and are not available to plants. Burning organic material changes nutrients from complex forms unavailable to plants to simpler and readily available forms in ash (Alaska Wildland Fire Coordinating Group 1998).

The effects of fire on northern ecosystems are discussed in Alaska Wildland Fire Coordinating Group (1998) and Duschesne and Hawkes (2000). The following discussion, and references cited therein, is from these reports. Generally, fire favors rapidly growing species, particularly grasses, and there is a decreased abundance of slow-growing species such as evergreen shrubs following a fire. The recovery of mosses and lichens is slow, as opposed to sedges and grasses (Bliss and Wein 1971). Establishment of pioneer species is mainly by wind-borne seeds (Viereck and Schandelmeier 1980, Auclair 1983). Most lichens establish within the first years following a burn, but their slow growth limits their abundance for the first 25 to 30 years.

The depth of burn has a great effect on the postfire community. If a fire just scorches or burns the surface of the organic mat, for the most part killing just the aboveground stems, rapid and often prolific sprouting occurs from roots, rhizomes, and root crowns of species found in the surface organic layers. If fire heat penetrates into the organic mat, killing plant parts to some depth but not consuming all organic matter, sprouts may develop from deeply buried plant parts. Severe wildfire favors species with deeply buried structures over those with structures primarily in the upper organic layer.

Efforts to contain or stop the spread of fire in the tundra often produce more drastic long-term effects than the fire itself (Brown 1971, Viereck and Schandelmeier 1980). Construction of firelines with bulldozers strips away all insulating moss and peat layers and exposes bare mineral soil. This allows the summer heat to penetrate directly into the frozen ground, which in turn increases the depth of the active layer under the firelines compared to under burned areas. As a result, there is a more rapid and greater degree of subsidence under the firelines than under the burned areas due to the melting of ground ice (Brown 1971), erosion, and gully formation (Brown 1983).

Subarctic Ecoregion. About 12% of proposed fire treatments would occur in the Subarctic Ecoregion. Natural fire return intervals in these communities are generally greater than 100 years, and are typified by surface fires of low to moderate intensity that generally kill conifers and aboveground plant parts, but do not destroy underground parts (Viereck and Schandelmeier 1980).

Prescribed fires of low to moderate severity that mimic natural fires would be expected to benefit plant communities in this ecoregion by facilitating the recovery of species such as sedge tussock and bluejoint that readily resprout after fire. Shrubs such as willows, cloudberry, and Labrador tea would begin to recover from fire quickly by resprouting from underground rhizomes, stems, or stump sprouts.

A high severity fire could destroy more of the organic layer, delaying the recovery of shrubs, and requiring some species to reestablish from seed sources. Areas of exposed mineral soil would favor forb seedlings such as fireweed, Jacob's ladder, and other early-successional species, as well as black and white spruce. In areas near the treeline, scattered trees could also be eliminated by fire because of the colder soils and increased soil moisture that would follow a high severity fire. All of these effects of fire, however, would be within the normal range of succession within subarctic plant communities, and would be unlikely to harm native communities unless areas were burned at a much greater frequency than under historical fire regimes.

Temperate Desert Ecoregion. Over 60% of fire treatments would occur in the Temperate Desert ecoregion, predominantly in evergreen shrubland (sagebrush) and evergreen woodland (pinyon-juniper) vegetation types.

<u>Evergreen Shrubland</u>. As discussed in Chapter 3, the sagebrush communities in the Temperate Desert Ecoregion vary in terms of species of sagebrush, shrub density, and richness of understory vegetation, largely in response to the amount of soil moisture on the site. In general, most species of sagebrush are quite susceptible to fire, and habitats may take many decades to recover (Brown and Smith 2000). Sagebrush is typically killed during a burn, and because most species do not resprout (Young and Evans 1977; Cluff et al. 1983), it must reseed after fire, requiring a fire-free period of at least 30 to 50 years to regain its dominance (Brown and Smith 2000) on most sites. Sagebrush communities in the temperate desert historically had a fire return frequency of 50 to 100 years, with fires typically increasing the importance of grass species until shrubs regained their dominance of the site. A typical "healthy" site, then, experiences periodic disturbances and

TABLE 4-5
Effects of Fire on Representative Invasive Species

Species	Enhancement of Colonization by Fire	Effects of Fire on Survival	Ability to Regrow after Fire
Bermudagrass	Unknown	Direct mortality unlikely	Dormant season burns enhance growth
Chinese tallow	Likely	Hot fires can topkill even large trees	Rapid recovery
Cogongrass	Slight enhancement	Mortality unlikely	Very rapid recovery
Crested wheatgrass	Likely	Various results reported	Various results reported
Downy brome	Likely	Killed by fire	Must reestablish by seed
Common buckthorn	Unknown	Seedlings die and mature trees topkilled	Rapid recovery
Japanese brome	Fire removes litter and inhibits colonization	Plants and seeds killed	Populations slow to recover
Kentucky bluegrass	Likely	Direct mortality low	Burns during spring growth period more strongly reduce plant density
Leafy spurge	Unclear	Mortality unlikely	Extremely rapid recovery
Musk thistle	Likely	Survival likely	Rapid recovery
Purple loosestrife	Unknown	Most survive	Rapid recovery
Quackgrass	Unknown	Direct mortality low	Plants can regrow quickly; may depend on burn time
Russian knapweed	Unknown	Some survival likely	Unknown
Saltcedar	Likely	Topkilled, but most survive and resprout	Rapid recovery
Smooth brome	Likely	Direct mortality low	Burns during spring growth period more strongly reduce plant density
Spotted knapweed	Enhanced	Substantial mortality	Population recovery aided by persistent seedbank
Yellow starthistle	Enhanced	Adult plants killed	Must recover by seed
Yellow sweetclover	Enhanced	Killed by growing-season burns	Rapid recovery by seed if burning infrequent

Source: Grace et al. 2001.

supports a mosaic of sagebrush communities in varying states of successional development.

At sites in which fires have been suppressed and the density of sagebrush plants has increased, prescribed burns would likely mimic a natural fire event by killing sagebrush and increasing the importance of the grass component of the community over the short term. At a site in Idaho, for example, prescribed fire in a sagebrush community generally supported increased grass cover for about 12 years, until shrubs regained their importance (Harniss and Murray 1973). Sagebrush regained its dominance after 30 years. Provided the site does not have a large component of non-native species, a prescribed fire would not alter the community over the long term. Repeated fires in less than 30- to 50-year cycles would generally adversely affect native communities by interfering with the cycle of plant succession, eventually reducing the dominance of sagebrush on the site, although mountain big sagebrush can be burned at intervals less than 30 years and still thrive.

On sites with a large component of invasive annual grasses, prescribed fires would likely negatively affect sagebrush communities by helping to maintain the dominance of downy brome, which outcompetes seedlings of most native perennial species on sites that have been burned. Once established, downy brome increases the frequency of fires and the uniformity with which they burn the landscape, thereby precluding the establishment of sagebrush and other perennial shrubs and grasses (Moseley et al. 1999).

Evergreen Woodland. It is believed that fire was the most important natural disturbance in pinyon-juniper

woodlands before the introduction of livestock in the 19th century (Gottfried et al. 1995). It is estimated that small surface fires historically occurred every 10 to 30 years (Leopold 1924) Large, stand-replacing fires occurred every 100 to 300 years (Paysen et al. 2000). Fires apparently restricted the junipers to shallow, rocky soils and rough topography (Arend 1950, Burkhardt and Tisdale 1969, O'Rourke and Ogden 1969). Under natural fire cycles, the successional stages following fire are typically annuals; mixed annuals and perennials; perennial forb; grass and shrub; shrub and pinyon-juniper; and climax pinyon-juniper. On sites with frequent fire, pinyon-juniper communities are rarely dominant, because pinyon pines and juniper trees are killed by fire when they are young. Older stands may be less susceptible because trees have thicker bark and more open crowns. On sites where pinyon pines and juniper trees become dense and canopies overlap or canopy gaps are small. Competition from trees usually causes a loss of the shrub and herbaceous layer, making the site less capable of carrying fire, or of supporting a fire of sufficient intensity to carry into the crowns of the trees.

TABLE 4-6
Plant Communities and Their Tolerance to Fire (based on interval between fire and recovery)

Level of Tolerance[1]	Plant Communities
Tolerant	Tallgrass prairie Northern mixed prairie Southern mixed prairie Chaparral Palouse prairie Oak woodland Mesquite-acacia woodland
Moderate tolerance	Shortgrass prairie California annual grassland Pinyon-juniper Mountain shrub
Low tolerance	Desert Alpine tundra Arctic tundra Semidesert grasslands Subarctic forests

[1] Tolerant = Interval between fire and recovery is 2-5 years; Moderate tolerance = Interval between fire and recovery is 5-15 years; Low tolerance = Interval between fire and recovery is 20+ years.
Source: Payne and Bryant (1988).

The effect of fire on pinyon-juniper communities would depend on the successional stage and species composition of the site. Pinyon-juniper communities that are regarded as "invasive" are those in which trees have established, or densities have increased as a result of fire exclusion, and in which pinyons and junipers outcompete herbaceous species for soil moisture and nutrients, altering the community structure. In many of these cases, pinyon-juniper woodlands have expanded into grassland and shrub-steppe/sagebrush habitats. Burning of these encroaching woodlands would benefit the plant communities that they have invaded.

Typically, the response of native understory species to fire is rapid and vigorous when the canopy cover of the pre-burned site is relatively open (Huber et al. 1999). Burning of sites with this amount of canopy coverage that are relatively undisturbed by human activities and non-native species could have a long-term positive effect by mimicking natural fire, opening up the site, and reducing accumulated fuel loads. However, in pinyon-juniper stands with over 40% canopy cover, post-fire succession would be reduced because of reduced numbers of understory plants capable of resprouting, and depleted seed reserves, negatively affecting native plant communities by allowing weeds such as downy brome to invade if the site is not reseeded.

Although a primary goal of fire treatments would be to utilize light burns to return dense pinyon-juniper communities to an earlier successional stage, adverse effects to native communities could occur if site conditions were not considered. For example, regrowth of native understory vegetation can be enhanced on sites with high soil moisture (Everett and Ward 1984) and restricted under dry conditions, such as drought (Paysen et al. 2000). An older stand of junipers with minimal understory diversity will recover differently than a younger stand with a highly diverse understory (Bunting 1984). Regrowth of native shrubs and grasses is unlikely to occur if these understory species are not present on the site prior to the burn. If downy brome or other undesirable species are present on the site, however, these species can increase in dominance after a fire treatment. Very hot fires, in particular, can seriously slow initial succession of desirable species (Bunting 1984). Use of fire treatments in areas where fire has been excluded could potentially increase fuels and associated fire risk on a site if fire-adapted annuals such as downy brome are present to spread into the treated site. Use of other treatment methods and/or

TABLE 4-7
Trees, Their Fire Resistance, and Their Ability to Regenerate after Fire[1]

Species	Ability to Regenerate after Fire	Size when Fire Resistance Gained[2]	Fire Resistance at Maturity
Pines			
Jack pine	None[3]	None	Low
Jeffrey pine	None	Pole	High
Longleaf pine	Root crown	Seedling[4]	High
Pinyon pine	None	None	Low
Pitch pine	Root crown, stump sprouts	Mature	Medium
Ponderosa pine	None	Sapling/pole	High
Red pine	None	Pole	Medium
Rocky Mountain lodgepole pine	None	Mature	Medium
Shortleaf pine	Root crown	Sapling[4]	High
Western white pine	None	Mature	Medium
Whitebark pine	None	Mature	Medium
Firs			
Balsam fir	None	None	Low
Douglas-fir	None	Pole/mature	High
Douglas-fir, Rocky Mountain	None	Pole	High
Grand fir	None	Mature	Medium
Noble fir	None	Mature	Medium
Pacific silver fir	None	None	Low
Subalpine fir	None	None	Very low
White fir	None	Mature	Medium
Junipers			
Eastern red cedar	None	None	Low
Oneseed juniper	None	Mature	Low/medium
Utah juniper	None	Mature	Low/medium
Western juniper	None	Mature	Low/medium
Other Conifers			
Alaska cedar	None	None	Low
Black spruce	None	Mature	Low/medium
Blue spruce	None	None	Low
Engelmann spruce	None	None	Low
Sitka spruce	None	None	Low
Tamarack	None	Mature	Medium
Western hemlock	None	None	Low
Western larch	None	Pole	High
Western red cedar	None	Mature	Medium
White spruce	None	Mature	Medium
Oaks			
California black oak	Root crown, stump sprouts	Mature	Low/medium
Canyon live oak	Root crown, stump sprouts	Mature	Medium
Gambel oak	Root crown, roots	None	Low
Oregon white oak	Root crown, stump sprouts	Pole	Medium
Post oak	Root crown, stump sprouts	Mature	Low/medium
White oak	Root crown, stump sprouts	Mature	Low/medium

TABLE 4-7 (Cont.)
Trees, Their Fire Resistance, and Their Ability to Regenerate after Fire[1]

Species	Ability to Regenerate after Fire	Size When Fire Resistance Gained[2]	Fire Resistance at Maturity
Other Hardwoods			
Aspen	Roots, root collar	Mature	Low/medium
Bigleaf maple	Root crown, stump sprouts	None	Low
Honey mesquite	Root crown, roots	None	Very low
Pacific madrone	Root crown	None	Low
Paper birch	Root collar	None	Low
Red alder	Stump sprouts	Mature	Low/medium
Red maple	Root crown, stump sprouts	Mature	Low/medium
White ash	Root crown, stump sprouts	None	Low

[1] The ratings of physical attributes are relative among the range of conditions observed for all tree species based on reviews of the literature.
[2] Sizes are defined as follows: seedlings = < 1 inch diameter at breast height [dbh]; saplings = 1-4 inches dbh; pole = 5-10 inches dbh; and mature = > 11 inches dbh. This is the size when medium or high fire resistance is gained.
[3] This species has serotinous cones and regenerates by seed following fire.
[4] For seedlings (longleaf and shortleaf pines) and saplings (shortleaf pine), shortleaf pine is a fairly strong sprouter and longleaf pine is a weak sprouter.
Source: Miller (2000).

reseeding after treatments would likely be necessary at these sites.

Mechanical methods of clearing pinyon-juniper woodlands are increasingly expensive, but prescribed fire is an economical alternative. The method used in Arizona is to ignite the crowns from prepared fuel ladders of cut lower limbs that are piled around the base of the tree. Ladders are ignited one season after the limbs are cut. In denser stands, fire spreads into the crown layer and through the stand from fuel ladders that are created below strategically placed trees. A method used in central Oregon on sites converted to juniper from sagebrush/grass is to conduct prescribed fires several years after cutting trees. The increased production of herbaceous vegetation following cutting provides fuels to carry the fire, which reduces residual slash and kills juniper seedlings (Paysen et al. 2000).

Research in the Great Basin suggests that fire is most effective on sites with scattered trees (9% to 23% cover) where the trees begin to dominate the understory and in dense stands (24% to 35% cover; Bruner and Klebenow 1979), because there is enough fuel to carry the fire, and enough understory vegetation to rapidly revegetate the site. Dense stands where pinyon pine is more common than juniper are easier to burn than pure juniper stands (Wright et al. 1979). Bunting (1984) indicated that burning of western juniper stands in southwestern Idaho was only successful during the mid-August to mid-September period; burning in the fall did not achieve desired results because of low temperatures, low wind speeds, and lack of fine fuels. Prescribed fire can be used in previously treated areas to control new tree regeneration. This technique is most effective if the area is ungrazed for one or two seasons prior to burning (Paysen et al. 2000).

Subtropical Desert Ecoregion. About 2% of fire treatments would occur in the Subtropical Desert Ecoregion, predominately in evergreen shrubland and perennial grassland communities. About half of the acres would be treated to reduce hazardous fuels, and half would be treated to improve watershed functions.

In many areas of the Mojave and Sonoran deserts, plant communities are too sparse during most years to adequately carry a prescribed fire. Therefore, this type of treatment would not be suitable for these areas. In areas that have increased fuel loading as a result of invasive annuals like downy brome, prescribed fire would negatively affect plant communities by encouraging the further spread of these invasive species. In the denser desert shrublands, where there is an adequate amount of fuel to support a fire, many shrubs, trees, and cacti could be severely affected by burning, as these species are not adapted to fire. Paloverde, burroweed, bursage, broom snakeweed, ocotillo, and creosote bush are examples of desert species that can

TABLE 4-8
Generalized Influence of Selected Brush Control Treatments on Vegetation.

Vegetation Control Method	Influence on Vegetation	
	Woody Plants	**Grasses and Forbs**
Fire	Short-term reduction in woody plant canopies and some woody plants often rapidly regrow.	Varies, but short-term decrease in herbaceous cover; fine mulch consumed; and there may be flush of herbaceous growth the first growing season because of increase in available nutrients.
Mechanical		
Top removal		
Shredding	Removes top ground and many species regrow vigorously.	Grass cover increases, but improvement may be short term.
Roller chopping	Generally the same as for shredding.	Generally the same as for shredding.
Hand slashing	Generally the same as for shredding.	Generally the same as for shredding.
Entire plant removal		
Grubbing	Individual plants extracted and little or no regrowth. Removes rhizomatous and stump-sprouting species.	General increase in herbaceous species.
Bulldozing	Removes stumps and large trees. Individual plants extracted; little or no regrowth. Small or limber plants may remain. Does not control rhizomatous and stump-sprouting species. Not suited for shallow or rocky soils. Least efficient clearing method.	Grass cover increases in interspaces; forbs increase in disturbed areas; and weeds may appear initially, but should revegetate to perennials.
Chaining/cabling	Large woody plants extracted. Small or limber plants remain. Thins or clears dense extensive mature trees stands. Most economical tree-felling method.	Grasses and forbs generally increase.
Root plowing	Woody plants removed by severing below ground line. Controls stump-sprouting species on large areas.	Grasses may be reduced and short-term increase in forbs.
Disk plowing	Thins or clears dense extensive mature shrub stands. Large woody plants extracted. Small or limber plants may remain.	Grasses are reduced and short-term increase in forbs.

Source: USDI BLM (1991a) and Payne and Bryant (1998).

suffer high mortality rates from burning (Wright and Bailey 1980).

Although fires would negatively affect desert shrublands, they would likely be beneficial in areas where fire suppression and/or overgrazing have resulted in the invasion of shrubs into desert grassland communities. The elimination of shrubs from these areas would encourage the return of native grass-dominated communities.

Fire as a management tool for controlling mesquite has its limitations. Mesquite may become more prevalent 5 years following a burn than it was before fire (Martin 1983). Mesquite can root sprout; top-killed individuals may resprout from dormant buds found in upper branches or from the base of the trunk below the ground surface. Mesquite seedlings can survive fire (Cable 1961), but on a burned site mesquite is sometimes reduced (Wright 1980). Fire may kill a good proportion of mature mesquite, particularly the smaller trees (<2 inch diameter; Cable 1949, 1973). It is most susceptible to fire during the hottest and driest part of the year (Cable 1973). Drought years may increase mortality of mesquite if eradication is attempted.

Low-intensity fire may allow mesquite to retain apical dominance on upper branches while reducing overall foliage. Single and repeated summer burns kill mesquite aboveground, but do not kill roots (Ansley et al. 1995). Prescribed burning may be used to kill mesquite seedlings while leaving tree sized and

TABLE 4-9
Percentage of Acres Projected to be Treated using Fire in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregions	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	6	0	0	7	57	1	1	4	22
Deciduous forest	2	0	0	0	0	0	0	3	4
Mixed evergreen/deciduous forest	1	0	0	0	<1	0	0	1	4
Evergreen woodland	19	0	0	92	30	0	15	16	19
Deciduous woodland	<1	0	0	0	3	0	<1	<1	0
Mixed evergreen/deciduous woodland	<1	0	0	0	<1	0	0	0	0
Evergreen shrubland	48	0	0	0	3	53	37	69	28
Deciduous shrubland	12	0	100	0	0	9	0	<1	0
Evergreen dwarf-shrubland	<1	0	0	0	0	0	0	<1	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	6	0	0	1	0	12	46	<1	16
Annual graminoid or forb	2	0	0	0	6	0	0	2	0
Perennial forb	<1	0	0	0	<1	0	<1	<1	0
Riparian/wetland	<1	0	0	<1	<1	<1	1	<1	0
More than one subclass	5	0	0	0	<1	25	0	6	7
Total for all ecoregions	100	0	12	2	5	2	9	63	7

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

shaped older individuals, preventing mesquite density from increasing.

Temperate Steppe Ecoregion. Seven percent of fire treatments would occur in the Temperate Steppe Ecoregion. Vegetation types that would likely receive fire treatments include evergreen forests, evergreen shrubland, and perennial graminoid communities.

Perennial Graminoid. Prescribed fire could have either positive or negative effects on plains grasslands of the Temperate Steppe Ecoregion, depending on its timing and severity. In some areas, use of infrequent, low severity fires could benefit grasslands by preventing the encroachment of woody species. Some shrubs, however, would be difficult to control using fire. Honey mesquite and sand shinnery oak, for example, both have the ability to resprout vigorously after fire (Wright and Bailey 1980). In addition, fires may not reach high enough to kill taller shrubs that are encroaching into shortgrass habitats.

Frequent or severe fires could harm plains grasslands communities by removing vegetative cover and facilitating erosion. These effects would be exacerbated during periods of drought, when wind erosion can retard the process of succession. Prairie grasses would also take longer to recover from fires occurring during dry years than from fires occurring during years with above-normal precipitation. For example, buffalograss, annual bluegrass, and western wheatgrass can take 3 or more years to recover from burns during dry periods (Wright and Bailey 1980). However, during years with precipitation that is above-normal, these grass species can be very tolerant of fire (Wright 1974).

In mountain grassland communities, where fire has been actively suppressed, prescribed fires could be beneficial by removing encroaching woody species such as ponderosa pine, Douglas-fir, lodgepole pine, and sagebrush. Frequent or severe fires could harm Idaho fescue, which can withstand burning under some conditions, but recovers slowly from fire when killed because it has to rely on its seedbank for recovery. Needlegrasses can also be severely damaged by fire. Burning when soils are moist would be expected to

result in the least amount of harm to native grass species in mountain grassland communities.

Evergreen Forests. Open forest types (e.g., ponderosa pine, Douglas-fir, and western larch) would likely benefit from low-intensity prescribed fires, which would reduce the density of understory shrubs and tree seedlings, and encourage vigorous and abundant herbaceous vegetation. In areas with substantial fuel accumulations, pre-treatment fuel reductions would be necessary in order to avoid high-intensity stand-replacing fires. Such high-intensity fires, much like stand-replacing wildfires, would harm these forest communities by damaging the dominant overstory tree species and cause soil damage, long-term structural conversion to brush, and loss of biodiversity (Brown and Smith 2000).

Failed attempts to restore more natural stand conditions with prescribed burning alone may result from inappropriate use of fire as a selective thinning tool in dense fire-excluded stands, or from burning too little or too much of the accumulated forest floor fuels. A better approach to the latter problem may be to apply two or even three burns to incrementally reduce loadings (Harrington and Sackett 1990). Once a semblance of the desired stand and fuel conditions have been established, stands can thereafter be maintained with periodic burning or a combination of cutting and fire treatments. Prescribed fire can be used in wilderness and natural areas to maintain natural processes.

Forests dominated by aspen often occur as interspersed or extensive stands within the evergreen forests of the Rocky Mountains. Fire exclusion has threatened the continued existence of aspen by allowing conifer seedlings to increase in dominance. The return of fire disturbances to aspen forests would stimulate their regeneration. Low severity fires kill conifer seedlings and thin aspen to encourage all-aged stands, while high severity fires result in new even-aged stands (Duchesne and Hawkes 2000). However, it is often difficult to get fires to carry in aspen stands under conditions that would support low severity fires. Fires in aspen stands often cannot occur until a large number of conifers are present.

Subtropical Steppe Ecoregion. Approximately 9% of fire treatments would occur in this ecoregion. Vegetation types that are proposed for vegetation treatments include perennial graminoid communities, evergreen shrublands, and evergreen woodlands. Treatments would focus on reducing hazardous fuels, improving conditions in the WUI, and controlling weeds.

Perennial Graminoid. The xerophytic grasslands of the Subtropical Steppe Ecoregion support sparse shrubs and low trees, and exist on a continuum with evergreen woodlands (described below). The common plant species of Subtropical Steppe grasslands would show a variety of responses to fire.

Fire may stimulate or damage grasses, depending on climatic conditions, season, and fire severity (Brown and Smith 2000). In addition, perennial grasses are mildly to severely harmed by fires during dry years, but quickly recover during wet years (Wright and Bailey 1980). Although bunchgrass species vary in their individual susceptibility to fire damage, repeated fires at intervals of about 5 to 40 years historically maintained the bunchgrass community. Encroachment into grasslands by woody species was an ongoing process kept in check by repeated fires (Gruell et al. 1986).

Evergreen Shrubland. Chaparral shrub species in the Subtropical Steppe Ecoregion are fire-dependent and comprised of highly flammable species, and sites recover rapidly after fire (Brown and Smith 2000). The production of dead fuels in chaparral stands is not well understood, but probably increases with age and after a drought. Fuels in chaparral communities are not as easily ignited as grass fuels, but will burn readily under hot, dry conditions.

Prescribed burns in chaparral communities would be expected to benefit these communities, provided fires were not too frequent or too hot, by reducing fuel accumulations and increasing structural diversity (Paysen et al. 2000). Typically, the aboveground shrub biomass would be killed by fire, but many species (e.g., scrub oak, leather oak) are deep rooted and would sprout readily from the root crown after burning (D.E. Brown 1982). The seeds of many species can withstand high soil temperatures (Agyagos et al. 2001). After prescribed fire, early successional herbaceous plants, especially annual grasses and forbs, would initially be abundant, but shrubs would dominate the site again after about 4 years. Too-frequent fires could negatively affect chaparral habitats by damaging young or resprouting shrubs before they became reproductively mature, thus depleting the seedbank. These alterations in the fire cycle could cause the typically dominant chaparral shrubs to be outcompeted by herbaceous vegetation. In addition, some chaparral communities have accumulated so much fuel that the severity of a prescribed fire in these areas would be much larger than

that of historical fires, potentially causing excessive damage to chaparral communities and requiring a long recovery time. Burning during a drought would also increase the severity of a fire in chaparral stands.

Individual shrubs can be killed outright by fire, and shrubs lacking in vigor will probably not respond to fire normally. Thus, stresses such as drought might cause an unexpected effect if fire were to be introduced. An extremely severe fire can result in little reproduction from either sprouting or seed germination. A series of fires with short return intervals may result in reduced chaparral shrub density if shrubs burn before they reach seed-bearing age, or if young shrubs developing from sprouts are physiologically unable to respond (Paysen et al. 2000).

Evergreen Woodland. The general effects of fire on pinyon-juniper woodlands in this ecoregion would be largely the same as the effects on pinyon-juniper woodlands in the Temperate Desert Ecoregion. There would be benefits to surrounding communities being invaded by pinyons and juniper trees, and potentially negative effects to communities with a large component of non-native species, or in pinyon-juniper stands with over 40% canopy cover (Paysen et al. 2000).

Mediterranean Ecoregion. Fire treatments in the Mediterranean ecoregion would be directed at evergreen forest and evergreen woodland. About 5% of fire use would occur in this ecoregion, and treatments would support efforts to improve forest health and reduce hazardous fuels.

Evergreen Forest. Evergreen forests in this region historically had an understory fire regime or a mixed severity fire regime, and are presently at risk for high-intensity, stand-replacing crown fires due to large fuel accumulations. Suppression of the mixed patchy fires in high elevation forests may eventually result in a landscape mosaic consisting largely of contiguous stands with comparatively heavy loadings of dead trees (standing and fallen) and canopy fuels. Prescribed fire treatments could benefit these forests by creating open, early successional conditions, reducing hazardous fuel loads, and improving forest health (Arno 1988). In addition, open forest types could benefit from understory burns, as discussed under evergreen forests the Temperate Steppe Ecoregion. In many cases, pre-treatment fuels reductions (e.g., thinning and pile burning) would be necessary to reduce the severity of prescribed burns. High severity or too-frequent fires could kill overstory species and reduce post-fire recovery rates, altering the species composition of forests over the long term. Fire history and experience burning in white fir types suggest that understory burning might be useful in some California red fir/lodgepole forests (Petersen and Mohr 1985; Weatherspoon 1990).

Evergreen Woodland. In recent centuries, fire regimes in western oak forests were characterized by frequent, low intensity fires. This was probably due to use of these areas by Native Americans, who probably carried out programs of frequent underburning. Frequent, low intensity fires helped to maintain open stands with a grassy understory. In the last half of the 20th century, higher severity fires at longer intervals were more common. Such fires can kill a stand of oaks outright (Brown and Smith 2000), although most oaks will resprout after fire if the underground portions of the plant are still alive (Plumb 1980). Because conditions in oak woodlands have changed significantly since historic fire regimes, there are many concerns surrounding the use of prescribed fire in these systems. Reintroduction of low severity fire into these communities could benefit them by killing young oaks and other woody species, restoring the open conditions that these ecosystems historically supported. Large oaks would be unlikely to be harmed during a low severity fire. A high severity wildfire, however, could kill much of an oak woodland's understory, increasing the recovery time of the community and potentially altering species composition.

Marine Ecoregion. Approximately 2% of fire treatments would occur in the Marine Ecoregion, primarily in evergreen woodlands and forests.

Evergreen Woodlands. Oak woodlands are maintained by frequent, low severity burning (Agee 1993). The effects of prescribed fire in these communities would be similar to those discussed for oak woodlands in the Mediterranean Ecoregion, above.

Evergreen Forest. Maritime forests are extensive at lower and middle elevations west of the Cascades and British Columbia Coast Range. The cooler, wetter, and more northerly portions of the coastal Douglas-fir type (generally associated with the mountains of western Washington and southwestern British Columbia) burned in stand-replacement fires at long intervals, averaging 200 to several hundred years (Agee 1993).

Western hemlock is the potential climax dominant tree, but seral Douglas-fir, which arose after replacement fires during the last several hundred years, is the actual dominant. The greater size and longevity of Douglas-fir

allows it to persist in considerable quantities for 700 to 1,000 years between major stand-opening disturbances such as fire or severe blowdowns (Agee 1993). Scattered individual Douglas-fir survived fires and served as seed sources in the burn. Seeds of this species may also survive and mature in the crowns of some trees whose foliage was killed (but not consumed) by a late-summer fire. The seeds are also wind-dispersed from unburned stands. Douglas-fir seedlings grow readily on burned seedbeds and outcompete other conifers in the postburn environment.

Due to the great length of natural fire intervals, it is unlikely that significant successional changes have occurred in most of these forests (especially in Washington) as a result of attempts to exclude fire during this century. Large areas of these forests have been clearcut in recent decades, sometimes followed by broadcast burning. This has given rise to large areas of early seral communities dominated by native flora, often with planted Douglas-fir, which might offset a shortage of early seral communities resulting from natural fires. However, natural burns and clearcuts differ ecologically, for example, in seedbed preparation, in providing residual large woody debris, and in having an overstory of dead trees (Kauffman 1990).

Effects of Mechanical Treatments

Approximately 80% of mechanical treatments would occur in the Temperate Desert Ecoregion, and 7% and 5% would occur in the Temperate Steppe and Mediterranean ecoregions, respectively (Table 4-10). Forty-one percent of treatments would occur in evergreen shrubland and 18% in evergreen woodland communities. Drill seeding would be the most common method used, comprising a third of treatments; mowing and chaining would comprise 10% and 6% of treatments, respectively.

Mechanical treatments would injure or kill plants by removing some or all of the plant material on the treatment site. Undesirable vegetation and fuel loads would be targeted, with an overall goal of restoring ecosystem health. Mechanical treatments are typically selective and would minimize damage to non-target plants present at the treatment site.

Mechanical methods are effective in removing thick stands of vegetation, but have limited use for noxious weed control, unless followed up with herbicide treatments, because the machinery can spread seed and not kill roots.

Methods that remove entire plants by plowing or cutting roots would cause the most mortality to non-target plants, limiting their ability to recover without seeding. In many cases, revegetation would be required after treatments to ensure the recovery of the plant community and limit the invasion of the treated site by non-native species. Thus, mechanical treatments associated with revegetation, such as drill-seeding, would typically have both short-term and long-term positive effects by aiding in the recovery of native plant communities on a treated site. Methods that remove only aboveground plant biomass (e.g., mowing) would have few lasting effects on native plant communities, as non-target species would typically be able to recover quickly by resprouting.

Mechanical treatments would generally have the greatest effect on woody plant species, which typically take about 10 years or longer to recover and regain their dominance, depending on the effectiveness of control and the reproductive success of the species. Herbaceous plants would typically be more resilient to top-removal treatment methods, as many of these species die back annually. Growth of herbaceous plants often increases after mechanical treatments as a result of reduced competition with woody species for light, nutrients, and water (Cox et al. 1982). Treatments occurring during the growing period and prior to seed maturation and dispersal would have the greatest potential effects on herbaceous species.

The use of vehicles and other mechanical equipment could negatively affect native plant communities by bringing the propagules of non-native species into treatment sites and creating sites for weed establishment. In addition, repeated mechanical treatments, or treatments that remove large areas of vegetation, could adversely affect native communities by altering species composition.

Tundra Ecoregion. No mechanical treatments are proposed to occur in this ecoregion. However, if mechanical treatments were to occur in this ecoregion, effects to vegetation associated with mechanical equipment would depend on the type of equipment, the vegetation type, and whether or not snow was present. In general, low ground-pressure wheeled vehicles would have less effect on tundra than tracked vehicles or sleds on skids (USDI BLM 2005c).

The use of OHVs such as four-wheel vehicles and snowmachines could cause localized effects to tundra. Snowmachines used during the winter when the ground is frozen and there is adequate snow cover would have

TABLE 4-10
Percentage of Acres Projected to be Treated using Mechanical Methods in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregions	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	8	0	0	15	22	1	19	3	41
Deciduous forest	1	0	0	0	0	0	0	1	3
Mixed evergreen/deciduous forest	1	0	0	0	<1	0	0	0	1
Evergreen woodland	20	0	0	81	56	1	63	14	18
Deciduous woodland	<1	0	0	0	<1	0	1	0	0
Mixed evergreen/deciduous woodland	<1	0	0	0	<1	0	0	0	0
Evergreen shrubland	40	0	0	0	16	13	13	46	22
Deciduous shrubland	<1	0	0	0	0	16	0	<1	<1
Evergreen dwarf-shrubland	0	0	0	0	0	0	0	0	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	4	0	0	3	2	2	0	4	<1
Annual graminoid or forb	8	0	0	0	3	0	0	9	1
Perennial forb	<1	0	0	0	0	0	<1	<1	<1
Riparian/wetland	<1	0	0	<1	<1	6	0	<1	0
More than one subclass	18	0	0	0	1	60	4	21	14
Total for all ecoregions	100	0	0	4	5	1	3	80	7

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

little or no effect to the vegetation. However, heavy use of a trail could cause compaction of vegetation. In addition, the use of snowmachines during fall or spring or in areas without adequate snow cover could result in damage to the vegetative mat leading to thermokarst. Similarly, use of four-wheel vehicles on tundra could disrupt the vegetation and churn soil in the upper portion of the profile, leading to thermokarst in wet tundra and damage or death of plants in drier areas. The use of airboats in shallow marsh areas could also affect vegetation and soil, although if confined to the river channel, airboats would have no effect on vegetation.

Subarctic Ecoregion. No mechanical treatments are proposed to occur in this ecoregion. If mechanical treatments did occur, they would occur predominantly in mixed evergreen/deciduous forests and evergreen forests. Treatments would involve thinning of spruce, aspen, and poplar forests to reduce hazardous fuels, particularly in the WUI. Treatments would be expected to improve the health and vigor of overstory trees by reducing competition for nutrients and water from dense understory vegetation. Thinning would increase light availability to understory vegetation and encourage early-successional, light-dependent species. The overall effect of understory thinning treatments would be positive, as it would reduce the risk of future stand-replacing fires, and make the treated area more suitable for supporting fire treatments that mimic the historical fires in these forests.

Temperate Desert Ecoregion. An overwhelming majority of the proposed mechanical treatments would occur in the Temperate Desert Ecoregion, in evergreen shrubland (sagebrush) and evergreen woodland (pinyon-juniper) communities.

Evergreen Shrubland. Most of the mechanical treatments in evergreen shrubland would involve tilling or plowing of sagebrush, followed by seeding or drilling. Other mechanical treatments, such as mowing, chopping, and chaining, would be used to a lesser extent. Treatments would target woody species (e.g., big sagebrush, rabbitbrush, and greasewood), with the goal of encouraging certain species of perennial bunchgrasses, forbs, and shrubs. Plowing would be used in areas with little herbaceous understory, where soil

disturbance would help prepare the seedbed for revegetation.

After treatment, there would be a temporary reduction in overall shrub cover, including both undesirable species (e.g., rabbitbrush, horsebrush, and greasewood) and desirable species (e.g., bitterbrush, cliffrose, and western serviceberry). In addition, the understory composition and environmental conditions of the treatment site would determine which herbaceous species would increase in cover following treatments. Overall grass production generally doubles after sagebrush removal, because the cover of sagebrush is reduced and soil nutrient and water availability is increased (Sturges 1975, USDI BLM 1991a).

Mechanical treatments that do not uproot vegetation would have little overall effect on plant species composition. However, compositional changes to overstory shrub species may occur, as certain shrub species are more adapted to this type of disturbance and would resprout readily, while others must reseed themselves from shrubs that survive treatment or from adjacent areas. Mowing treatments would favor herbaceous species rather than shrubs. However, mowing is generally not considered to be useful for long-term control of sagebrush, as the effects last less than 5 years (Davis 1982) and in general little overall effect on plant species composition would be expected in the long term. Mowing treatments are useful in improving the structural diversity of sagebrush stands.

Herbaceous species present on the site prior to treatment would uniformly increase in abundance, and some species of shrubs would resprout fairly quickly. Undesirable species on the site would be unlikely to decrease in abundance, and could be favored by quickly taking advantage of the resources released by the removal of shrubs. Methods of uprooting vegetation, such as plowing and disking, would be more likely to alter the species composition of sagebrush communities. Plowing would typically result in 70% to 90% sagebrush mortality, which would generally be higher in summer, when the soil is dry and firm, than during the spring, when the soil is moist and compactable (Cluff et al. 1983). However, plowing, when used alone, is not an effective method of controlling sagebrush, which is capable of reseeding rapidly, and could eventually result in greater canopy coverage of sagebrush than was present on the site prior to treatment (Wambolt and Payne 1986).

Although the use of mechanical treatments in evergreen shrublands would have some benefit to herbaceous species over the short term, these methods could have adverse effects to native communities over the long term if used inappropriately. For example, repeated control of sagebrush through methods such as plowing would eventually alter the species composition of native plant communities, especially if revegetated with seed mixtures, which may only contain seeds for a small portion of the herbaceous species native to the site. Furthermore, mechanical treatments would not adequately mimic the fire disturbance regime of sagebrush communities. In most cases, mechanical treatments would need to be combined with other types of treatments in order to avoid adverse effects to native plant communities.

Evergreen Woodlands. Mechanical treatments in pinyon-juniper woodlands would primarily consist of thinning and machine piling of debris, as well as chipping/shredding and chaining to reduce the occurrence of pinyon and juniper species. In some instances, trees might be cut and removed from the site. As a result of tree removal, many native perennial grass species, forbs, and shrubs would increase on the site (Clary 1971, Jacobs and Gatewood 1999). Therefore, successful treatments would benefit native plant communities. However, partial removal of trees would not have lasting benefits to native communities, and benefits would be minimal on sites where low precipitation or shallow soils limit revegetation of understory species. In addition, mechanical treatments on sites with a large component of non-native herbaceous species could result in increased dominance of these undesirable species. Pinyon-juniper sites that are mechanically treated would have to be retreated fairly often, as small trees and seedlings often survive these treatments and may rapidly regrow once free from competition.

Temperate Steppe Ecoregion. In the Temperate Steppe Ecoregion, mechanical treatments would likely occur in evergreen forest, evergreen shrubland, and evergreen woodland communities.

Evergreen Forest. Mechanical treatments in forest communities would largely consist of treatments to reduce tree density, remove ladder fuels, reduce crown bulk density, and alter tree species composition in favor of fire-resilient species. In forests where fires have been suppressed, mechanical treatments could create openings in the canopy usually caused by fire, increasing the germination of grasses in open forests (e.g., ponderosa pine) and of shade-intolerant tree species in more closed forests (e.g., aspen). These disturbances could benefit evergreen forests by

returning the treated site to an earlier successional stage, thereby mimicking the historical role of fire.

Improvement cutting, thinning, and understory cutting with whole-tree removal or pile burning may be necessary to achieve open stocking levels that will sustain vigorous tree growth and to reduce ladder fuels (Fiedler et al. 1996). Harvesting and thinning should be designed to retain the most vigorous trees. If stems are tall and slender, as in dense second growth stands, it may be necessary to leave clumps of three to five trees for mutual protection against breakage by wet snow and windstorms. The restoration cutting process may require thinning in two to three steps over 15 to 20 years. Spot planting of the desired seral tree species in open burned microsites can be used when shade-tolerant species have taken over.

Evergreen Shrubland. The general effects of mechanical treatments on sagebrush communities in this ecoregion would be largely the same as the effects on sagebrush communities in the Temperate Desert Ecoregion. However, plant communities in the Temperate Steppe Ecoregion would generally experience more rapid and favorable rates of recovery following treatments due to the greater precipitation that falls in this region compared with the Temperate Desert Ecoregion.

Removal of shrubs using techniques that cut only aboveground portions of vegetation would result in very little change to plant communities, as shrub species would rapidly resprout from buds in the base, rhizomes, or roots (Cable 1975). Techniques that uproot vegetation, however, would favor pioneer species. Given the lack of an undeveloped understory, the spread of weeds into these communities would be encouraged. Shrubs would also return from seeds, favoring species that do not require fire to germinate. Therefore, these treatments would be likely to affect native plant communities by altering their species composition over the long term.

Evergreen Woodland. The general effects of mechanical treatments on pinyon-juniper woodlands in this ecoregion would be largely the same as the effects on pinyon-juniper in the Temperate Desert Ecoregion, except they would be less limited by moisture availability.

Subtropical Steppe Ecoregion. In the Subtropical Steppe Ecoregion, mechanical treatments would likely occur in evergreen woodland and evergreen forest communities.

Evergreen Woodland. The general effects of mechanical treatments on pinyon-juniper woodlands in this ecoregion would be largely the same as the effects on pinyon-juniper in the Temperate Desert Ecoregion. The warmer and wetter conditions in the Subtropical Steppe Ecoregion would likely result in more favorable vegetation response following treatment compared to similar vegetation types in the Temperate Desert Ecoregion.

Evergreen Forest. The general effects of mechanical treatments on evergreen forests in this ecoregion would be largely the same as the effects on evergreen forests in the Temperate Steppe Ecoregion.

Subtropical Desert Ecoregion. In the Subtropical Desert Ecoregion, some mechanical treatments are likely to occur in evergreen and deciduous shrublands. Mechanical treatments could increase the cover of annual weeds, such as halogeton and Russian thistle, thereby adversely affecting native plant communities. Because of the extremely low and irregular rainfall of this region, it would be difficult to revegetate native species after widespread treatments (Bleak et al. 1965; Jordan 1981; Cox et al. 1982; Blaisdell and Holmgren 1984; Roundy and Young 1985). Reestablishment of perennial vegetation, in particular, may require successive years of unusually high precipitation. Therefore, mechanical treatments, because of their large area of influence, could have longer-lasting effects to native plant communities in the Subtropical Desert Ecoregion than to plant communities in the other ecoregions receiving treatments.

Mediterranean Ecoregion. In the Mediterranean Ecoregion, mechanical treatments would likely occur in evergreen woodland, evergreen forest, and evergreen shrubland communities.

Evergreen Woodland. Some changes in understory species composition could occur as a result of mechanical treatments, as certain species would respond favorably to mechanical treatments, and others would not. Finally, the use of heavy equipment in oak woodlands could negatively affect oaks. The shallow root systems of oaks could be physically damaged by heavy equipment.

Evergreen Forest. The general effects of mechanical treatments on evergreen forests in this ecoregion would be largely the same as the effects on evergreen forests in the Temperate Steppe Ecoregion.

Evergreen Shrubland. The general effects of mechanical treatments on chaparral communities in this ecoregion would be largely the same as the effects on chaparral in the Temperate Steppe Ecoregion.

Marine Ecoregion. In the Marine Ecoregion mechanical treatments would likely occur in evergreen woodland and evergreen forest communities.

Evergreen Woodland. The general effects of mechanical treatments on oak woodlands in this ecoregion would be largely the same as the effects on oak woodland in the Mediterranean Ecoregion.

Evergreen Forest. The general effects of mechanical treatments on evergreen forests in this ecoregion would be largely the same as the effects on evergreen forests in the Temperate Steppe or Mediterranean ecoregions. However, evergreen forests in the Marine ecoregion would likely recover more quickly from mechanical treatments due to the more abundant rainfall in this region.

Effects of Manual Treatments

Over half (53%) of manual treatments would occur in the Temperate Desert Ecoregion, and one-quarter of treatments in the Mediterranean Ecoregion. A third of manual treatments would occur in evergreen forest, 23% in evergreen woodlands, and 9% in evergreen shrublands (Table 4-11).

Manual treatments would generally benefit native plant communities on public lands, without the risks of adverse effects to non-target species associated with most of the other treatment methods. Manual methods are highly selective, causing injury and mortality only to target plants/fuels, and because of their high cost, would only be used in limited areas where other treatment methods were not feasible. Most of the manual treatments would occur in evergreen shrublands and woodlands of the Temperate Desert Ecoregion, and in evergreen forests of the Mediterranean and Marine ecoregions. Manual treatments in evergreen forests would consist primarily of hand thinning by chainsaws to reduce stand densities and reduce hazardous fuels, and pruning to reduce ladder fuels. In all ecoregions and vegetation types, manual treatments could result in small amounts of trampling or accidental removal of non-target plants, particularly since repeated treatments are often required to prevent the reestablishment of aggressive weeds. There would also be minor risks associated with spilling oil and fuels from hand-held equipment, such as chainsaws, which could kill or harm plants. The overall effects to native communities, however, would be minimal and short term in duration.

Effects of Biological Treatments

Nearly 90% of biological control treatments would occur in the Temperate Steppe (48%) and Mediterranean (40%) ecoregions (Table 4-12). Over half of treatments would control annual grasses or forbs (e.g. medusahead and yellow starthistle) and 25% of treatments would control perennial forbs (e.g., some knapweeds, some thistles, leafy spurge, purple loosestrife, and dalmatian toadflax).

Containment by Domestic Animals. About two-thirds of the acres to be treated using biological methods would be subject to grazing by animals. These treatments would generally occur in herbaceous communities (annual and perennial grassland and perennial forb communities) that have significant weed infestations.

Domestic animals would likely affect non-target vegetation by browsing and trampling/kicking up plants. The extent of effects to non-target vegetation would depend on the animal species used, the plant species' tolerance to grazing, management of the grazing system (i.e., timing, area, intensity, frequency, and duration), and the site's pre-treatment condition and disturbance history. Different types of livestock have different food preferences. Sheep and goats typically prefer broadleaved forbs, although sheep will generally consume more grass than goats (Walker et al. 1994). Cattle prefer grasses (Olson 1999). These diet preferences could result in alterations to plant species composition after prolonged periods of grazing.

Many weed species are of poor forage quality and have low palatability due to toxins, spines, and distasteful compounds, which would cause domestic animals to avoid them in favor of native plant species. The effects of grazing would be greatest when conducted before plants have produced seed (resulting in reduced reproductive capacity), during times of drought or stress, or if conducted repeatedly.

Because of the numerous factors involved in determining the extent of effects to native plant communities from grazing, the BLM's grazing management systems would be required to involve the right combination of animals, timing, and stocking density, and be carefully designed, managed, and monitored, in order to avoid effects to native plant communities on treatment sites (Olson 1999).

TABLE 4-11
Percentage of Acres Projected to be Treated using Manual Methods in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregion	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	32	0	0	89	86	0	3	2	34
Deciduous forest	<1	0	0	0	0	0	0	1	1
Mixed evergreen/deciduous forest	2	0	0	0	<1	0	0	1	2
Evergreen woodland	21	0	0	8	3	0	61	28	23
Deciduous woodland	<1	0	0	<1	0	0	0	0	0
Mixed evergreen/deciduous woodland	0	0	0	0	0	0	0	0	0
Evergreen shrubland	14	0	0	0	2	98	9	23	9
Deciduous shrubland	<1	0	0	0	0	<1	0	0	0
Evergreen dwarf-shrubland	0	0	0	0	0	0	0	0	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	10	0	0	2	<1	0	0	20	1
Annual graminoid or forb	<1	0	0	0	1	0	0	<1	0
Perennial forb	2	0	0	0	5	0	0	1	7
Riparian/wetland	2	0	0	2	2	1	26	1	<1
More than one subclass	15	0	0	0	<1	1	0	22	22
Total for all ecoregions	100	0	0	12	24	<1	4	53	7

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

The use of domestic animals could indirectly affect native plant communities by encouraging weed infestations as a result of soil disturbance, which creates sites for weed establishment, and by spreading propagules in fur or dung. For example, livestock have been a major contributor in the dissemination of mesquite seeds into mesquite-free areas (Archer 1995). Therefore, grazing treatments not confined to areas of high weed infestation could adversely affect the surrounding native plant communities, or other sites to which grazers were moved, by increasing the coverage of weeds within them.

Livestock could alter the nutrient cycling processes of native plant communities receiving grazing treatments by depositing organic nitrogen in urine and feces, and by mixing surface organic matter. In traditionally nitrogen-limited ecosystems, such as those found in the arid West, increased nitrogen could benefit native plants (LeJune and Seastedt 2001). However, most nitrogen-limited systems contain species that are adapted to low nutrient levels, and deposition of nitrogen could actually favor weeds that require high nitrogen concentrations to become established (Evans and Ehleringer 1993). High soil nitrogen could also assist in the spread of established weeds, such as downy brome and medusahead, by stimulating seed germination (Belsky and Gelbard 2000).

Significant biological control treatments are proposed for the annual graminoid/forb communities of the Mediterranean Ecoregion. Of note is a single large proposed grazing project. Because annual grasslands in California evolved in conjunction with heavy grazing regimes, grazing treatments would be unlikely to cause major changes to the vegetation communities that currently exist (Sims 1988).

Biological treatments would also be prevalent in the Temperate Steppe Ecoregion, spread over a number of vegetation types. Prominent treatments would include grazing in perennial graminoid/forb and riparian communities in Montana.

Biological Control Agents. The effects of insects and pathogens on native plant communities are difficult to assess, as they have not been well documented. In

some cases, biological control agents can be very beneficial to plant communities with heavy weed infestations by reducing the vigor and dominance of their target weed species. For example, the release of flea beetles at one site was found to reduce densities of leafy spurge stems by 65% within 3 to 5 years after their release (Lym and Nelson 2000). Regardless of their degree of success in restoring degraded communities, the insects and pathogens approved for release under the proposed treatment programs would be unlikely to affect non-target species or cause any adverse effects to native plant communities. Biological control agents are tested extensively before being approved for field release to ensure host specificity (i.e., acting only on their target plants), and reports of extensive damage to non-target organisms are not widespread. However, the relationship between laboratory testing and field behavior is not always predictable, and there may be some potential risks to non-target plants. For example, a weevil released to control exotic thistles has also been observed to feed on native thistle flowerheads (Louda et al. 1997). Though adverse effects to native plant communities are not expected as a result of treatments using insects and pathogens, there would still be risks associated with unforeseen effects to these communities.

Release of insects would be prevalent in the Temperate Steppe Ecoregion in perennial graminoid and forb communities. Other plant communities currently scheduled to receive biological control treatments include perennial forb communities in the Temperate Desert Ecoregion, perennial graminoid communities in the Subtropical Desert and Marine ecoregions, and evergreen forests in the Subtropical Steppe Ecoregion. Biological treatments are not proposed for the Tundra or Subarctic ecoregions.

Effects of Chemical Treatments

The effectiveness of herbicide treatments in managing target plants and the extent of disturbance to native plant communities would vary by the extent and method of treatment (e.g., aerial vs. ground) and chemical used (e.g., selective vs. non-selective), as well as by local plant types and physical features (e.g., soil type, slope) and weather conditions (e.g., wind speed) at the time of application. Treatments would likely affect the plant species composition of an area and could affect plant species diversity. Species composition and species diversity are equally important contributors to ecosystem function (USDA Forest Service 2005). Because certain herbicides target certain types of plants (e.g., broadleaf species), an herbicide treatment program for a given ecosystem and area should include multiple types of herbicides. For example, if picloram or clopyralid were the only herbicides used in a highly invaded area, weedy annual grasses, such as medusahead, downy brome, and barbed goatgrass could begin to dominate. The following sections detail the possible effects of herbicide treatments on both target and non-target plants.

Over 70% of the treatment acres would be in the Temperate Desert Ecoregion, a much greater proportion than at present (Table 4-13). Sixteen percent of treatments would occur in the Temperate Steppe Ecoregion. Treatments in the Temperate Desert Ecoregion would primarily target sagebrush, rabbitbrush, and other evergreen shrubland species, and annual grass and perennial forb weeds, while those in the Temperate Steppe Ecoregion would focus on control of invasive annual and perennial grasses and forbs.

Non-target Plants. Herbicides could come into contact with and affect non-target plants through drift, runoff, wind transport, or accidental spills and direct spraying. Potential effects include mortality, reduced productivity, and abnormal growth. Risk to off-site plants from spray drift would be greater for applications with smaller buffer zones and from greater heights (i.e., aerial application or ground application with a high boom). Risk to off-site plants from surface runoff is influenced by precipitation rate, soil type, and application area. Most accidental scenarios (i.e., direct spray or spill) pose a risk to plant receptors. Persistent herbicides (e.g., bromacil) adsorbed to soil particles could also be carried off site by wind or water, affecting plants in other areas. Application rate is a major factor in determining risk, with higher application rates more likely to pose a risk to plants under various exposure scenarios.

Applications that would pose the greatest risk to non-target plant species, assuming SOPs were followed, are those with the greatest likelihood of off-site transport. The risk characterization process of the ERAs indicated that risk to typical terrestrial plants associated with off-site drift of bromacil, clopyralid, chlorsulfuron, dicamba, imazapyr, metsulfuron methyl, and triclopyr would be moderate to high. The risks to special status terrestrial plants associated with off-site drift of bromacil, clopyralid, chlorsulfuron, dicamba, diquat, diuron, imazapyr, metsulfuron methyl, sulfometuron methyl or triclopyr would be

TABLE 4-12
Percentage of Acres Projected to be Treated Using Biological Control Methods in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregion	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	<1	0	0	14	<1	0	49	0	0
Deciduous forest	0	0	0	0	0	0	0	0	0
Mixed evergreen/deciduous forest	0	0	0	0	0	0	0	0	0
Evergreen woodland	<1	0	0	0	<1	0	0	0	0
Deciduous woodland	0	0	0	0	0	0	0	0	0
Mixed evergreen/deciduous woodland	0	0	0	0	0	0	0	0	0
Evergreen shrubland	4	0	0	0	3	0	51	14	0
Deciduous shrubland	0	0	0	0	0	0	0	0	0
Evergreen dwarf-shrubland	0	0	0	0	0	0	0	0	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	14	0	0	86	<1	100	0	7	23
Annual graminoid or forb	38	0	0	0	97	0	0	6	<1
Perennial forb	13	0	0	0	<1	0	0	59	18
Riparian/wetland	2	0	0	0	<1	0	0	0	4
More than one subclass	29	0	0	0	0	0	0	14	4
Total for ecoregion	100	0	0	<1	40	2	<1	8	48

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

moderate to high. There would be moderate risk to aquatic plants associated with off-site drift of diuron applied at the maximum application rate. None of the herbicides pose risk under wind erosion scenarios.

Effects to non-target plants would be minimal if herbicides were able to selectively target the desired species type. Herbicides that are selective for broad-leaved plants (e.g., imazapic and clopyralid) would only affect broad-leaved species, which are typically the only target species in grass-dominated plant communities. However, some changes in species composition could occur in these communities as a result of altered competitive relationships. The lasting effects of treatments using non-selective herbicides would depend on reestablishment of species present in the seedbank. In many cases, reseeding or replanting treatments would be required after the application of non-selective herbicides to ensure the presence of native species on the site following treatment.

The ALS-inhibiting herbicides evaluated in the PEIS are chlorsulfuron, imazapic, imazapyr, metsulfuron methyl, and sulfometuron methyl. These herbicides would be applied at low application rates, since only small concentrations are necessary to damage target plants. These herbicides would pose some risks to non-target plants; however, risks would be similar to those associated with the other evaluated herbicides. Nevertheless, because of the potency of these herbicides, they would be most appropriate for use against a dominant target species or a particularly aggressive invasive species that has not been controlled by other methods (USDA Forest Service 2005).

Target Plants. The effects of herbicides on target plants would depend on their mode of action. Contact herbicides (e.g., diquat) only kill the plant parts that they touch, while translocated herbicides (e.g., dicamba) are transported throughout the plant. Herbicides that provide long-term weed management (e.g., bromacil) affect plants when they are present in the soil, with the degree of damage and non-selectivity often increasing with herbicide concentration (Holecheck et al. 1995).

TABLE 4-13
Percentage of Acres Projected to be Treated Using Herbicides in Each Ecoregion for Each Vegetation Subclass

Vegetation Subclass[1]	All Ecoregions	Tundra	Subarctic	Marine	Mediterranean	Subtropical Desert	Subtropical Steppe	Temperate Desert	Temperate Steppe
Evergreen forest	4	0	0	79	76	0	<1	1	1
Deciduous forest	<1	0	0	0	0	0	0	<1	<1
Mixed evergreen/deciduous forest	<1	0	0	0	0	0	0	0	<1
Evergreen woodland	2	0	0	0	6	0	1	2	<1
Deciduous woodland	<1	0	0	0	<1	5	5	0	0
Mixed evergreen/deciduous woodland	0	0	0	0	0	0	0	0	0
Evergreen shrubland	33	0	0	0	8	26	42	36	21
Deciduous shrubland	<1	0	0	0	0	32	4	<1	0
Evergreen dwarf-shrubland	0	0	0	0	0	0	0	0	0
Deciduous dwarf-shrubland	0	0	0	0	0	0	0	0	0
Perennial graminoid	13	0	0	21	<1	0	33	8	26
Annual graminoid or forb	15	0	0	0	10	0	8	20	2
Perennial forb	12	0	0	0	<1	<1	1	12	23
Riparian/wetland	1	0	0	0	<1	2	4	1	0
More than one subclass	20	0	0	0	0	34	3	21	26
Total for all ecoregions	100	0	0	<1	4	<1	9	71	16

[1] See Table 3-4 and Vegetation section in Chapter 3 for a description of vegetation subclasses.

Selective herbicides only affect certain plant species, whereas non-selective herbicides affect all or most plant species. The non-selective herbicides evaluated in the PEIS include bromacil, diquat, diuron, fluridone (except at low concentrations), glyphosate, sulfometuron methyl, and tebuthiuron. The other herbicides (2,4-D, chlorsulfuron, clopyralid, diflufenzopyr, hexazinone, imazapic, imazapyr, metsulfuron methyl, Overdrive®, picloram, and triclopyr) exhibit some selective qualities. Diquat and fluridone would be used exclusively for the management of aquatic plants. 2,4-D, glyphosate, imazapyr, and triclopyr could be used for management of aquatic as well as terrestrial vegetation.

Beneficial Effects of Treatments

Treatments that remove hazardous fuels from public lands would be expected to benefit the health of plant communities in which natural fire cycles have been altered. The suppression of fire results in the buildup of dead plant materials (e.g., litter and dead woody materials), and often increases the density of flammable living fuels on a site (e.g., dead branches on living shrubs or live plants, especially during dry periods). The resultant fires burn hotter, spread more quickly, and consume more plant materials than the historical fires that occurred under conditions of lower fuel loading. In addition, human-caused fires occur with greater frequency than they historically did, resulting in altered plant community structure. Treatments that restore and maintain fire-adapted ecosystems, through the appropriate use of mechanical thinning, fire use, and other vegetation treatment methods, would decrease the effects from wildfire to communities and improve ecosystem resilience and sustainability. Treatments should also reduce the incidence and severity of wildfires across the western U.S.

Treatments that control populations of non-native species on public lands would be expected to benefit native plant communities by reducing the importance of non-native species and aiding in the reestablishment of native species. The use of fire, herbicides, or other treatment methods to simply kill vegetation is often inadequate, especially for large infestations. Introducing

and establishing competitive plants is also needed for successful management of weed infestations and the restoration of desirable plant communities (Jacobs et al. 1999). The degree of benefit would depend on the success of these treatments over both the short and long term. Some treatments are very successful at removing weeds over the short term, but are not successful at promoting the establishment of native species in their place. In such cases, seeding of native plant species would be beneficial. Weeds may resprout or reseed quickly, outcompeting native species, and in some cases increasing in vigor as a result of treatments. The success of treatments would depend on numerous factors, and could require the use of a combination of methods discussed below to combat undesirable species.

Although modeling was not done as part of this PER to determine the long-term effects of vegetation treatments, modeling done for similar treatments proposed by the BLM and Forest Service in the Interior Columbia Basin showed that improvements in land condition would be slow. The drier parts of the restoration area would likely take longer to restore than wetter areas because the vegetation would respond more slowly and because treatment methods are less refined for more arid ecosystems (USDA Forest Service and USDI BLM 2000b).

Based on conclusions drawn from the Interior Columbia Basin assessment, public land treatments would provide a better mix of habitats so that vegetation would be more resilient to disturbance and sustainable in the long term. Treatments should reduce the extent of Douglas-fir and other shade tolerant species from current levels. Treatments would reduce the encroachment and density of woody species in shrublands and/or herblands. As a result, plant communities that have declined substantially in geographic extent from historical to current periods (e.g., big sagebrush and bunchgrasses) would increase. Although the acreage of weeds and other exotic and undesirable plants could continue to increase, the rate of expansion should be slower (USDA Forest Service and USDI BLM 2000b).

Effects of Fire Treatments

Fire suppression has altered natural fire regimes and led to an increase in hazardous fuels and the associated risk of catastrophic fire in the West. In addition, several weed and invasive plant species have increased dramatically due to altered fire cycles. Use of fire would help to restore native vegetation and natural ecosystem processes. It is effective in controlling some invasive annuals with short-live seed banks, such as downy brome, especially when followed up with herbicide treatments (Asher et al. 2001; Grace et al. 2001). One strategy for altering the balance between non-native annuals and native perennials is to burn early during the spring after the ground has dried out. Fires at this time would destroy much of the seed crop of both annuals and perennials, although the resprouting of the latter would make them more resilient to burning (Keeley 2001). However, other invasive species populations, such as leafy spurge, burningbush, bull thistle, sowthistle and diffuse knapweed, could be stimulated with fire, especially if large seedbanks were present (Harrod and Reichard 2001). In addition, restoration, including seeding, would have to occur in a timely manner after treatment to minimize the potential for erosion or weed invasion (Brooks and Pyke 2001).

Prescribed fire treatments in the arid perennial grasslands would potentially benefit these communities by controlling the invasion of shrubs such as mesquite, creosote bush, and tarbush. Fire can be used to deter the growth and invasion of several invasive shrubs, including mesquite (Grace et al. 2001). Fires may kill the seeds of this species, and be effective in topkilling smaller shrubs (Drewa et al. 2001). Fire has also been used to control cholla and pricklypear. In the Chihuahuan Desert, fire can be used to stimulate herb and grass production. If invasion by weeds is not likely, fire can be used in chaparral to open dense stands and improve habitat for wildlife. In mountain shrublands, fire use can improve species diversity (Payne and Bryant 1998). Fires at 5- to 40-year intervals would maintain perennial bunchgrass communities. Vegetation can be used as living firebreaks or greenstrips. Crested wheatgrass has been used as a firebreak because it photosynthesizes longer into the growing season compared with most native species in the Temperate Desert Ecoregion and therefore stays greener longer and is less capable of carrying a fire.

Effects of Mechanical and Manual Treatments

Mechanical and manual treatments would allow for more precise control of vegetation in the treatment area than other methods. In addition, mechanical and manual treatments pose fewer human health risks than fire use and use of herbicides, and would thus be favored for treatments in the WUI, along ROWs, and near high public use areas.

Manual and mechanical methods are often used for maintenance of ROWs and public facilities. Common manual techniques used at these sites include pulling, cutting, girdling, topping, and pruning. Chainsaws are

used by crews that travel along ROWs and remove target vegetation. Manual methods can be highly selective and remove only targeted vegetation. They can also be safer to use around powerlines and other hazard sites (BPA 2000).

Manual and mechanical treatments are effective in sensitive areas, such as wetland and riparian habitat, or near the habitat of plant and animal species of concern, where greater control over treatment effects is required or effects to non-target species are a concern. Equipment can be used to thin trees to increase the distance between tree crowns in order to reduce the chance that fire will spread between them, or to remove ladder fuels to reduce the possibility that a surface fire will become a crown fire. Chaining and shredding are effective in the control of shrubs, such as mesquite and juniper, and for management of sagebrush (Payne and Bryant 1998).

Materials generated from thinning and other vegetation treatments are available for use as soil amendments, as pulp chips for the paper industry, as construction material, or as biomass for fuel. The conversion of unwanted vegetation to biomass energy has gained more importance as our nation has become more reliant on foreign sources of energy. Specific sources of residue to biomass energy production include lands that have been degraded by the expansion in the distribution of woody species, such as western juniper, and by the accumulation of shade tolerant species within the Intermountain West. It is estimated that the BLM alone has the available biomass equivalent to 100,000 tons of coal on lands suitable for biomass production (USDI BLM 2006c).

Mechanical methods are often used to prepare a seedbed before planting. Dozer blades, grubbers, rootplows, disks, chains, and cables can be used to remove brush, roughen the seedbed, or shred vegetation that can be used as mulch. Seeding is accomplished by broadcast seeding, drill seeding, and by hand planting, among other methods (Payne and Bryant 1998).

Chaparral communities would receive mechanical treatments to reduce woody vegetation and increase herbaceous vegetation for improved forage or water yield, as well as for fuels reduction. Many species of chaparral communities are highly flammable, fire-dependent species. Chaparral communities tend to produce an abundance of dead fuels, which could be reduced with mechanical treatments.

Mechanical treatments could benefit native communities by controlling woody shrub species, which have invaded desert grasslands and now occur in much greater densities than they have historically. Mechanical treatments, when properly conducted and timed, can effectively control desert shrub species, such as creosote bush (Wood et al. 1991).

Mechanical treatments in oak woodlands would benefit native plant communities by removing conifers and other encroaching woody species that have increased the density of these communities, and by stimulating the growth of understory forbs and grasses. In these regards, mechanical treatments could act as a “replacement” for the historical fire disturbances that maintained the openness of oak woodlands. Treatments that favor oaks would also allow oaks to grow large and increase their reproductive success.

Effects of Biological Treatments

Biological control is a useful and proven method for controlling rangeland and aquatic weeds. The aim of biological control is not to eradicate the target species, but rather to put enough pressure on the species to reduce its dominance to more acceptable levels. Biological control is cost-effective, environmentally safe, self-perpetuating, and is well-suited to integration within an overall weed program (Wilson and McCaffrey 1999). Biological control agents have the additional advantage of not harming non-target vegetation.

A number of biological control agents are effective in controlling noxious weeds and invasive vegetation. The BLM would use insects, pathogens, and livestock to control vegetation. Insects are prominent in biological control of weeds because many species exhibit high host-specificity (Wilson and McCaffrey 1999). However, the success of biological control programs often depends on the presence of a more desirable plant community that can fill in the spaces opened by the removal of the weed. Thus, biological control would not be effective where large stands of annual grasses, such as downy brome, are present and have displaced native vegetation. If the weed is controlled, the space is often filled by another weed, or the plant community reverts to the weed annual grass understory.

The use of grazing animals has a greater likelihood of affecting non-target vegetation than insects and pathogens. Although grazing animals such as goats, sheep, and cattle are often looked upon negatively in terms of effects on vegetation, they can beneficially alter the appearance productivity, and composition of

plant communities if used in moderation and at appropriate stocking densities (Payne and Bryant 1998). Goats are effective in controlling shrubs such as oaks, mesquite, chamise, and sumac on desert shrublands and chaparral (USDI BLM 1991a). Goats are also effective in controlling vegetation in sensitive areas where use of fire or herbicides is undesirable, such as near residential areas or near streams and wetlands.

Effects of Chemical Treatments

Herbicides offer an effective and often resource-efficient means of treating and managing unwanted vegetation. Mechanical and manual treatments are often more time and labor intensive than herbicide applications, and they cause soil disturbance, which can provide the appropriate conditions for invasive weeds to resprout from roots and rhizomes or grow from dormant seeds. In addition, herbicide use may be less dangerous than treatment with prescribed fire in dry areas that have high fire risk. The use of herbicides would benefit plant communities with weed infestations by decreasing the growth, seed production, and competitiveness of target plants, thereby releasing native species from competitive pressures (e.g., water, nutrient, and space availability) and aiding in their reestablishment. The degree of benefit to native communities would depend on the toxicity of the herbicide to the target species, and its effects on non-target species, as well as the success of the treatments over both the short and long term.

Some treatments are very successful at removing weeds over the short term, but are not successful at promoting the establishment of native species in their place. In such cases, seeding of native plant species would be beneficial. The success of treatments would depend on numerous factors, and could require the use of a combination of methods to combat undesirable species. In addition, repeated use of a particular herbicide on a particular site could cause target weeds to develop a certain level of resistance to that herbicide over time, reducing the effectiveness of repeated treatments.

The focus of treatments in the Temperate Desert Ecoregion is to benefit greater sage-grouse and other wildlife that use sagebrush communities by creating openings in dense and crowded sagebrush and rabbitbrush stands, removing invasive species, and promoting production of perennial grasses and forbs desired by wildlife (Paige and Ritter 1999).

Treatments in the Temperate Steppe Ecoregion would be focused on annual and perennial grasses and forbs, including downy brome, knapweeds, and thistles. Control of broadleaf plants by selective herbicides, such as 2,4-D, usually increases grass production. 2,4-D is also effective in controlling weedy forbs, such as bull, musk, and Scotch thistle. 2,4-D can be tank mixed with other herbicides, such as glyphosate, dicamba, picloram, and triclopyr to enhance the activity of these herbicides. Applications of selective herbicides, such as 2,4-D, are expected to increase grasses and decrease broadleaf species (USDI BLM 1991a).

Herbicides such as picloram and tebuthiuron are used to control woody species such as mesquite, creosote bush, and snakeweed in Subtropical Desert Ecoregion habitats. These herbicides usually decrease woody plant growth and increase growth of grasses, although it may take several years before grass and forb production increases in response to reduced competition from shrubs. Picloram is effective in controlling snakeweed, while tebuthiuron is effective in controlling creosote bush and tarbrush (USDI BLM 1991a).

New herbicides proposed for use by the BLM (Overdrive®, diquat, fluridone, and imazapic) pose lower risks to terrestrial plants than bromacil and chlorsulfuron, and present similar or lower risks to terrestrial plants than the other currently-approved herbicides. Imazapic has been reported to successfully control the spread of aggressive invasives, including downy brome, Russian knapweed, and perennial pepperweed, would pose few risks to non-target vegetation, and would have positive effects on native prairie restoration (Whitson 2001, Shinn and Thill 2002).

Effects to Special Status Plant Species

Public lands in the western U.S. support over 1,000 plant species that have been given a special status based on their rarity or sensitivity. Special status plants include approximately 150 species that are federally-listed as threatened or endangered, or are proposed for federal listing. The remaining special status species include candidates for federal listing, and other species that warrant special attention and could potentially require federal listing in the future. Many of these species are threatened by competition with non-native plants and other invasive species. The *Final Programmatic Biological Assessment Vegetation Treatments on Bureau of Land Management Lands in 17 Western States* (BA; USDI BLM 2007b) provides a description of the distribution, life history, and current threats for each federally-listed plant species, as well as species proposed for listing.

In general, the potential effects to special status plant species from the proposed vegetation treatments would be similar to those described for vegetation as a whole in the previous section. However, the rarity and sensitivity of special status species and their habitats make them more likely to be affected by disturbances associated with treatments. For all treatments, additional mitigation is required. In addition, populations of special status species may in some cases benefit more from fuels reduction and control of non-native species than plants with secure populations.

Standard Operating Procedures

The BLM would implement SOPs to minimize the risks to special status plant species from vegetation treatments. Examples of SOPs include surveying for species of concern if the project may impact federally- and/or state-listed species; minimizing direct impacts to species of concern from fire treatments, unless studies show that these species will benefit from fire; minimizing the use of ground-disturbing equipment near species of concern; and using temporary roads when long-term access to treatment sites is not required (see Table 2-5).

Adverse Effects of Treatments

Effects of Fire Treatments

As discussed in the BA, the potential effects of fire treatments on special status plant species would vary depending on a number of factors. The timing of the burn; the area, frequency, and severity of the burn; the level of resistance or adaptation by individual species to fire; the presence of fire-adapted vegetation; and the historical fire disturbance regime of the habitat would all influence the effects on special status population in the area. In most cases, mortality of some plants would occur if a fire were to burn directly through a population. The negative effect on the population would increase if a severe fire were to kill subsurface reproductive structures, or buried seeds. If an entire population was burned, extirpation of that population could potentially occur. Low intensity burns in fire adapted habitats could potentially benefit some special status species by increasing flower production and/or seed germination.

The indirect effects on special status plant species as a result of changes in habitat would largely depend on conditions of the site. Many special status species on public lands, particularly species found in the Marine Ecoregion, are early-successional species that would be expected to benefit indirectly from prescribed burns. In some cases special status plants would need to be protected from fire while the surrounding habitat was burned.

In habitats where non-native species have become adapted to fire (often in rangelands), fire treatments would be expected to further degrade the quality of the habitat because the fire-adapted invasive species would potentially outcompete native special status species in occupying sites cleared by burning.

As discussed in the BA, the majority of desert special status species (in Temperate Desert and Subtropical Desert ecoregions) occur in desert shrub communities. Pending an assessment at the local level prior to treatment, it is assumed that most special status plant species in desert habitats would be adversely affected by fire treatments because they are not likely to be adapted to fire. It is also assumed that the majority of special status plant species in the Subtropical Steppe Ecoregion would be adversely affected by fire. Many of these species are members of stable, climax communities that would not be expected to benefit from fire treatments. Many special status plants in the Temperate Steppe Ecoregion would be expected to respond positively to fire treatments, as many habitats in this ecoregion adapted with fire and grazing. The Mediterranean Ecoregion Division also contains a variety of habitat types, such as chaparral, oak woodlands, and grasslands, which are fire adapted and would be expected to benefit from the use of prescribed fire. Special status plant species in the Marine Ecoregion Division are also likely to benefit from fire. At the local level, BLM offices would need to make a determination about the possible effects of fire on special status plant species and their habitats prior to implementing fire treatments.

Effects of Mechanical and Manual Treatments

Because mechanical treatments are intended to control entire stands of vegetation or to enhance structural diversity, they could result in injury or mortality to any special status plants present on the treatment site if these plants were not avoided. In instances where the top layer of soil was removed, the seed bank of the species would also be negatively affected. Species with small populations or very limited distributions could be extirpated by such an occurrence. Populations of annual special status plants, however, should not be adversely affected, provided seedbank and germination conditions were not negatively affected by the treatment.

Effects to the habitat of special status plant species, in addition to the potential long-term benefits from the removal of weeds, would include short-term adverse effects such as erosion and hydrologic alteration, as discussed under effects to vegetation.

Over the long term, the suitability of the treatment site for supporting special status plant species would depend on the suite of species that became established after the site was cleared. A site cleared but not replanted or reseeded would typically favor early successional species, and would be expected to be beneficial for early successional special status plants. However, noxious weeds are also well-adapted to disturbed sites, and in many cases can outcompete special status plant species. It is expected that mechanical treatments would occur on sites with a large amount of undesirable vegetation, and it is likely that propagules of these species would be able to recolonize the site. Thus, it is possible that mechanical treatments alone would have no long-term effect on special status species habitat, or would have a negative effect. However, if replanting or reseeding with native species was also done at the site, long-term effects could be positive, by eventually replacing a site dominated by non-natives species to one dominated by native species.

Manual treatments would potentially provide benefits to special status species without causing injury to individual plants, provided workers were able to identify special status species and avoid disturbing them.

Effects of Biological Treatments

Containment by Domestic Animals. Adverse effects to special status plants and/or their habitat from weed containment by domestic animals could include foraging of individual plants, trampling, compaction of soils, and, for wetland species, hydrologic alteration. Although plants are typically able to recover from removal of their aboveground portions, heavy grazing could cause a reduction in plant biomass, vigor, and seed production (Kauffman 1988, Heady and Child 1994). In the case of non-secure populations of special status plants, the stresses associated with grazing could cause long-term adverse effects, particularly if special status plants were browsed or grazed before producing seed, or during times of drought or other environmental stress, or if the same plants were grazed repeatedly. Although treatments with domestic animals can improve the habitat of some special status species by reducing the cover and vigor of non-native or undesirable species, grazing can reduce the quality of habitat by spreading weed propagules. Since many populations of special status species occur in areas that have a large component of native species, introduction of weed propagules into these areas would be expected to have long-term adverse effects on special status populations.

Other Biological Control Agents. No adverse effects to special status plant species are expected from the use of biological control agents, since these insects and pathogens generally do not affect non-target plant species or habitats. However, there have been some instances of biological control agents attacking species other than the target plant. An example is the seed-head weevil, which was released to control alien species of thistle, but has also attacked the Chorro Creek bog thistle, an endangered species in the same genus. Under the review process, biological control agents undergo an extensive screening and testing process by USDA Animal and Plant Health Inspection Service before an organism can be released. Despite these safeguards, there is always a risk that the release of an agent into a habitat in which it does not occur could result in unforeseen ecological repercussions.

Effects of Chemical Treatments

The potential effects of herbicide treatments on special status plant species would depend on a number of factors, including the location of the application in relation to special status populations, the type of application method utilized, the type of chemical formulation used, and the timing of the application in relation to the phenology of the special status species. In the case of special status plant species, manual spot applications of herbicides may be the only suitable means of applying herbicides that can adequately ensure the protection of sensitive populations.

All of the herbicides analyzed in ERAs would pose risks to terrestrial special status plant species in a situation where plants were directly sprayed. Herbicides with the greatest likelihood of harming special status plants would include bromacil, chlorsulfuron, clopyralid, diflufenzopyr, diquat, imazapyr, metsulfuron methyl, Overdrive®, picloram, sulfometuron methyl, and triclopyr. These herbicides would also present the most risk to terrestrial special status plant species as a result of drift from a nearby application site. The herbicide with the lowest risk to terrestrial plants is imazapic, which, according to its ERA, can be broadcast sprayed by ground methods 25 feet from a sensitive plant without risk (ENSR 2005c-l; Syracuse Environmental Research Associates, Inc.[SERA] 2005).

Herbicides with the greatest likelihood of affecting special status plant species via surface runoff include imazapyr, metsulfuron methyl, picloram, and triclopyr. Of these herbicides, picloram has the longest soil half-life (see Soil Resources section). Herbicides with the least likelihood of affecting special status terrestrial plant species include imazapic, chlorsulfuron, glyphosate, and bromacil.

Aquatic special status plants could be harmed by a normal application of an aquatic herbicide, accidental direct spray or spray drift of a terrestrial herbicide from a nearby upland, accidental spill, or surface runoff from an upslope area into the water body where the plant is located. Use of 2,4-D and diquat to control vegetation in aquatic habitats would pose the greatest risks to any special status plant species also in the habitat. Aquatic herbicides that would be safe for use in aquatic habitats where special status plant species occur include fluridone and the low-toxicity formulations of glyphosate. In addition, triclopyr acid could be applied directly to the water column at the standard concentration without harm to sensitive aquatic plants. The safest terrestrial herbicides to use near aquatic habitats would be picloram and diflufenzopyr.

Beneficial Effects of Treatments

Many special status plant species are threatened by the spread of non-native plants. Although a discussion of individual plant species is beyond the scope of this PER, the BA provides additional information on which threatened, endangered, and proposed plants are most at risk from competition with non-native plants. The continued spread of non-native plants is expected to result in further encroachment on rare or sensitive plant populations, possibly resulting in reduced population size and vigor, and even extirpation of particularly vulnerable populations. Therefore, all vegetation treatments that limit the spread of non-native plants in habitats occupied by special status species would benefit these vulnerable populations. Improvement of habitat near populations of special status species could also be extremely beneficial by providing suitable habitat for expansion of populations, perhaps aiding in their recovery.

Because populations of special status plants are often small and isolated from other populations, they are highly susceptible to extirpation by catastrophic wildfires, even in habitats that are, or were once, adapted to fire. Therefore, vegetation treatments that reduce fuels in and near populations of special status species would be expected to provide long-term benefits to these species by reducing the likelihood that a future wildfire would extirpate or further weaken sensitive populations (Sheppard and Farnsworth 1997).

Prescribed fires may release resources to the benefit of special status plants. Plant height and numbers of flowerheads of Thompson's clover were significantly higher in burned than unburned areas where fires removed competing grasses and shrubs (Scherer et al. 1997).

Hand removal of competing vegetation and fuel sources within populations of special status species would likely help improve or maintain the vigor of these populations. Though not feasible over large areas, manual treatments are often the most appropriate means of improving habitats occupied by threatened and endangered species.

Fish and Other Aquatic Organisms

The BLM administers lands directly affecting almost 155,000 miles of fish-bearing streams and 4 million acres of reservoirs and natural lakes (USDI BLM 2006c). These habitats range from isolated desert springs of the Southwest to large interior rivers and their numerous tributaries throughout the Pacific Northwest and Alaska. Today, the rapid expansion of invasive species and build-up of hazardous fuels across public lands are threats to ecosystem health and one of the greatest challenges in ecosystem management.

The BLM vegetation treatment program is designed to benefit ecosystems by removing and controlling the spread of invasive plant species. In aquatic systems, these plants (e.g., Eurasian watermilfoil and water-thyme) may clog slow-moving water bodies, contaminating water with an overabundance of organic material. Dense concentrations of invasive aquatic plants also reduce light and dissolved oxygen levels, eliminating habitat and decreasing growth or killing native species of plants and animals (Payne and Copes 1986). Fire exclusion policies, buildup in hazardous fuel levels, and increase in acreage dominated by invasive vegetation have led to more frequent fires of greater severity and duration and increased soil erosion over many areas of the West. These conditions have often led to deterioration in water quality and fish habitat in affected areas. Efforts to improve upland habitat conditions by reducing hazardous fuel levels and controlling invasive species and noxious weeds should lead to improved habitat for fish and other aquatic organisms.

Scoping Comments and Other Issues Evaluated in Assessment

Numerous scoping comments were centered around a desire for the BLM to focus on long-term ecosystem sustainability and biological diversity. There was some concern about herbicide bioaccumulation in fish. Many reviewers expressed a desire that the BLM use newer, less toxic herbicides and/or limit or avoid herbicide use.

Resource Program Goals

Approximately 30,000 acres of wetland and riparian habitat would be treated annually to benefit fish and other aquatic organisms. Of these acres, approximately 34% would be treated using chemical treatments, 30% using biological control methods, 28% using mechanical and manual methods, and 8% using fire. Herbicide treatments would be conducted using aerial and ground-based equipment, and more than 80% of treatments would occur in the Temperate Desert and Subtropical Steppe ecoregions. Biological control treatments would mostly involve the use of insects. Nearly all fire treatments in riparian areas would be 100 acres or less.

Uplands would be treated to meet other project objectives, including reducing hazardous fuels, reducing the risk of fire in the WUI, and improving habitat for wildlife. These treatments, however, would also likely improve plant community structure and function to the benefit of fish and other aquatic organisms in the treatment area.

The BLM has ongoing programs under the direction of the Fisheries Management, Riparian Management, and Soil, Water and Air Management programs to control invasive vegetation and noxious weeds, including saltcedar, in riparian areas. The BLM is working with Ducks Unlimited and other groups to create wetlands and improve stream habitat. Substantial effort is focused on removing and revegetating abandoned logging roads to reduce erosion and sedimentation of nearby aquatic bodies, and to restore habitat for salmon and other fish in the Columbia River Basin (USDI BLM 2005a). Columbia River Basin activities include fencing riparian areas to better control livestock access. In addition, the BLM is actively restoring degraded lands in the Colorado River Basin to reduce the amount of salt loading to the Colorado River.

Fire exclusion policies, buildup of hazardous fuels, and increase in acreage dominated by invasive vegetation have led to more frequent fires of greater severity and duration and increased soil erosion over many areas of the West. These conditions have often led to deterioration in water quality and fish habitat in affected areas (USDA Forest Service and USDI BLM 2000b). Although disturbances from fire, wind, plant disease, grazing by wildlife, floods, and other factors will always be important in shaping ecosystems in the western U.S., efforts by the BLM to restore vegetation to more natural conditions, and reduce fuels buildup and the frequency of catastrophic fires, should lead to a slow improvement in habitat for fish and other aquatic organisms in treated areas.

Standard Operating Procedures

This assessment of effects assumes that SOPs (listed in Table 2-5 of the PER and Table 2-8 of the PEIS) are used to reduce potential unintended effects to fish and other aquatic organisms. These include developing and updating an operational plan for each project, which would include information on project specifications, key personnel responsibilities, communication procedures, safety, spill response, and emergency procedures. In addition, the BLM would maintain vegetated buffers between treatment areas and aquatic habitats. Vehicles would not be washed in streams or wetlands, and equipment would be fueled and serviced at least 100 feet from water bodies. Treatments would be minimized near fish-bearing streams, particularly during periods when fish are in sensitive life stages, and access of domestic animals to streams and other water bodies would be limited to minimize sediments entering water and potential for damage to fish habitat. For herbicide treatments, SOPs would include using spot, rather than aerial treatments, near water bodies, and using the herbicide that is least toxic to fish and other aquatic organisms, while still being effective. Minimum buffers and other herbicide use restrictions would be established based on guidance given in risk assessments prepared for the PEIS (see Appendix C of the PEIS) and the herbicide label.

Adverse Effects of Treatments

All vegetation removal activities could disturb the soil and reduce the amount of vegetation that can bind to soil, potentially causing erosion and sedimentation of water bodies. Fish typically avoid turbid or silty water, and the density and diversity of fish and macroinvertebrate populations tend to decline as streams become more silted (Gore 1985; Wagner and LaPerriere 1985; Aldridge et al. 1987; Steinman and

McIntire 1990). Sedimentation can affect the feeding success of fish species that rely on visual search strategies, bury prime spawning habitat, prevent fry (early-stage fish) from emerging from spawning gravels, and foul the gills of aquatic organisms (Gardener 1981). Sediments can also affect plants that are used as food by aquatic organisms by reducing the amount of sunlight reaching plants and slowing or stopping their growth.

Removal of riparian vegetation would increase the amount of sunlight reaching water bodies, which could raise water temperatures above normal. Water temperature affects the metabolism, behavior, and survivorship of aquatic species (Beschta et al. 1987, Bjornn and Reiser 1991). Salmon and trout are cold-water fish that are especially sensitive to above-normal water temperatures. Temperatures above 80°F are lethal to most salmonids. Many streams in the West that once supported cold-water species now host mostly warm-water species, such as common carp and red shiner, as stream temperatures have risen due to loss of streamside vegetation from agriculture and other vegetation-removing practices. Warmer water temperatures also stimulate the production of algae, especially in waters with a high nitrogen content. While increased algae production may benefit macroinvertebrate production, algae can also crowd out more desirable plant species.

The removal of vegetation and soil disturbance decreases the amount of rainfall captured by plants, detritus, and soil, and can lead to increased stormwater flows and runoff velocity (Spence et al. 1996). Increased stormwater runoff can scour stream channels and modify stream channel morphology, affecting the distribution and abundance of aquatic organisms (Hicks et al. 1991). Although many aquatic species have evolved life-history strategies that allow them to succeed under rapidly changing water conditions, other species, such as those using wetlands, depend upon more stable conditions. For example, vegetation removal resulting in increased water flows to wetlands during the spring could flood the breeding sites of aquatic organisms that breed or lay eggs in moist soil, harming or killing eggs or juveniles.

The loss of large trees to mechanical or manual treatments could reduce the amount of large woody debris that would later fall into the water body and provide food and shelter for fish and other aquatic organisms. Loss of woody debris has been identified as a contributing factor in the decline of salmon populations in the Pacific Northwest (BPA 2000). Woody debris provides food and shelter for aquatic organisms, helps to capture and store sediments, reduces the erosional effects of high stream flows, and enhances pool development and maintenance (Bisson et al. 1987). The effects of debris removal would be greatest for smaller water bodies, or where vegetation was removed along lengthy stretches (300 feet or more) of a stream.

Effects of Fire Treatments

Embers, burning vegetation, and radiant heat generated by fire can raise water temperature (Fresquez et al. 2002). High mortality of juvenile coho and cutthroat trout were observed in Oregon when water temperature rose from 55 °F to 82 °F during a wildfire (Hall and Lantz 1969). However, evidence suggests that the increase in water temperature due to fire is usually short-term and confined to the immediate area (Amaranthus et al. 1989).

Hazardous fuels reduction would also decrease the likelihood that wildfire suppression activities would occur in or near aquatic habitats. Fire suppression activities can adversely affect aquatic organisms and their habitats. Fire retardants contain chemicals (e.g., ammonium polyphosphate or ammonium sulfate) that are especially harmful to aquatic organisms (Viereck and Schandelmeier 1980, Finger 1995), with retardant foams being more harmful than other types of retardants (Gaikowski et al. 1996a, 1996b; McDonald et al. 1996, 1997). Retardant that drops in or close to streams could have negative effects on fish.

Ash and smoke produced by fires can affect water chemistry. Ash falling into a stream can increase ammonia concentrations and acidity (pH) in the stream (Spencer and Hauer 1991), which are harmful to a variety of fish (Minshall et al. 1989). Changes in water temperature and water quality can be especially harmful to macroinvertebrates. For example, one study found that nearly all macroinvertebrates died in a stream in Arizona where a wildfire occurred, and even a year later, population numbers were only one-third of normal (Rinne 1996). Changes in temperature and nutrients were related to the volume of water in affected streams.

High intensity fires could kill large trees, with increased stream flow and erosion caused by the loss of vegetation toppling these trees into aquatic habitats. Over the short term, this woody debris would provide new fish habitat, sometimes continuing to fall into the water body for a year or more (Young 1994; Minshall et al. 1997; Berg et al. 2002). Eventually, however, the loss of trees would

result in little new woody debris entering the stream for many years.

Fires also cause changes in soil structure that may exacerbate erosion problems. The burning of litter and organic matter can reduce infiltration and increase runoff. Although many soils are naturally water repellant when dry, the consumption of litter over coarse textured soils can sometimes cause a waxy coating to form around soil particles below the surface. These layers repel water, increasing runoff, and can persist for years, unless the physical structure of the soil is somehow altered.

There would typically be fewer effects to aquatic organisms from heat, smoke, and ash from low intensity fires than from large, high severity fires. Prescribed fires can be designed to kill mostly shrubs and deciduous trees, rather than larger conifers. Since large trees would remain, soil stability would not be impaired, and conifers would still be available to contribute large woody debris to aquatic bodies in the future.

Different groups of invertebrates vary in their sensitivities to fire-caused changes in aquatic systems. Both generalist insects (which can live under a range of physical conditions and eat a wide range of foods) and mobile insects (which can readily flee intolerable conditions) tend to be least affected by burning (Minshall 2003). The abundance of aquatic invertebrates, however, is unlikely to differ from that in unburned streams shortly after a prescribed fire.

Alaska and the Pacific Northwest

No fire treatments are scheduled to occur in the Tundra Ecoregion of Alaska. In the Subarctic Ecoregion of Alaska, forestlands and deciduous shrublands would receive most of the fire treatments. Natural fire return intervals in these communities are generally greater than 100 years, and are typified by surface fires of low to moderate intensity that generally kill aboveground plant parts, but do not destroy underground parts (Viereck and Schandelmeier 1980).

In the Marine Ecoregion of the Pacific Northwest, fire treatments are proposed to occur in evergreen woodlands. These communities typically existed as fire climax oak woodlands maintained by frequent, low intensity burning (Agee 1993). Evergreen forests within this ecoregion include rain-fed coastal streams and snow-fed streams. Salmonids are the key fish species, located throughout tributaries and mainstems in this region.

Fire has been a relatively common occurrence in evergreen forests of the Pacific Northwest over the last 10,000 years (McMahon and deCalesta 1990). Fish in this region are apt to seek refuge in waters unaffected by adjacent burning, leaving burned areas poorly stocked until conditions become favorable once again (Minshall et al. 1990; Rieman and Clayton 1997; Gresswell 1999). Fish isolated from safe havens due to the extent of the burn or the lack of connectivity between affected and unaffected waters, however, must suffer any ill effects of burning on their habitat. The short-term effects of fire on fish populations are a function of both the degree and duration of fire-caused changes in water quality and quantity, and the proportion of each inhabited stream network affected by burning. An isolated or fragmented fish population would recover far more slowly from any adverse effects of burning than would a population inhabiting a widespread and well-connected stream system.

Severe fires that burn much or most of the organic layer down to mineral soil or permafrost could result in increased siltation and runoff into streams, negatively affecting local fish populations with an increase in turbidity and a potential loss of habitat. Furthermore, water temperatures could rise as a result of increased exposure of the stream surface to direct sunlight after removal of riparian vegetation by fire. Fire can also increase landslide potential for up to 5 years after the event because of the decay of anchoring root systems (Meehan 1991).

Frequent or intense fires could harm fish populations by removing vegetative cover and facilitating erosion. The extent to which surface runoff would affect water bodies would depend on the timing of the fires and the surrounding gradient; the steeper the topography the greater the runoff. However, maintaining buffers between burning areas and the aquatic resources would ensure that effects from runoff would be lessened.

The eastern portion of the Pacific Northwest is predominantly Temperate Steppe and Subtropical Steppe ecoregions. Basin vegetation types that would likely receive fire treatments in these ecoregions include evergreen forests, evergreen shrubland, and perennial graminoid communities.

The evergreen shrubland areas supporting chaparral shrub species in the Subtropical Steppe Ecoregion are fire-dependent, comprised of highly flammable species that grow rapidly after fire, taking about 25 years to mature and senesce (Brown and Smith 2000). A wildfire could alter riparian vegetation and affect

aquatic areas. Burning riparian vegetation would reduce available riparian habitat, increase streambank erosion, raise water temperatures, and reduce oxygen levels (Wright and Bailey 1982). Fish species, such as longfin dace and desert suckers, could be more affected by large wildfires and associated suppression activities (e.g., fire line construction and retardant drops) than is desirable in evergreen shrubland riparian communities. These effects could include displacement, mortality, and adverse loss or modification of habitat (e.g., cover and food resources). Severe wildfires occurring during critical reproductive periods for these species would be the most detrimental.

Prescribed fire in this ecoregion is not expected to result in direct mortality of local fish communities or cause indirect adverse effects to their habitat, including loss of forage, thermal cover, and hiding cover, as these projects would be designed to protect riparian vegetation and maintain unburned patches of vegetation in upland areas.

The perennial graminoid grasslands in the eastern Pacific Northwest support sparse shrubs and low trees, and exist on a continuum with evergreen woodlands (USDA Forest Service and USDI BLM 2000b). Aquatic bodies are very susceptible to surface runoff and erosion upon removal of grasslands. This increase in vegetation removal could have a major effect on native fishes and their habitat. The extent to which surface runoff would affect water bodies would depend on the timing of the prescribed fires and the surrounding gradient; the steeper the topography the greater the potential runoff. If streamflow increases because of the removal of encroaching conifers, riparian and aquatic organisms could benefit.

The Arid Environment

The Great Basin. The main vegetation types that would be treated in the Temperate Desert Ecoregion are evergreen shrubland (sagebrush habitats) and evergreen woodland (pinyon-juniper habitats), with fire treatments predominantly occurring in evergreen shrublands.

While fish are adapted to extreme conditions in this region, those fishes living in small water bodies are most vulnerable to fire, which would modify the surrounding habitat and could change the amount of water in the system.

Fire is a natural process in the Great Basin, but with the spread of invasive grasses throughout evergreen shrublands, fires have increased in intensity and frequency. Fires have the potential to spread to riparian habitats, where loss of vegetation in riparian buffer zones is likely to destabilize stream banks and lead to erosion and sedimentation into aquatic habitats and potentially degrade fish habitat. Fire occurrence has decreased in upper elevation shrub communities, allowing establishment of substantial acreages of pinyon and juniper. Moisture competition eventually eliminates understory vegetation, resulting in substantial soil loss. Increased cover of surface vegetation and possible increase in soil water could lead to improved conditions in riparian and wetland areas.

On sites with a large component of invasive annual grasses, fires could negatively affect fish communities in the evergreen shrubland (sagebrush) areas. Because of the more continuous fuel loading on these sites, fires would affect a greater percentage of the surface on sites with a native-dominated understory. Residual vegetation would be less and initial recovery of weedy species would provide less protection to the soil surface than would a resprouting native grass community. Hot fires could increase the potential for surface erosion, although this is generally a temporary effect under prescribed fire conditions (DeBano 1981, Wright and Bailey 1982). Prescribed fires would likely be rare in sites dominated by invasive annual grasses, and would mostly used as a preparation for reseeding.

Lower Colorado River Basin. The Family Cyprinidae (chubs, dace, and suckers) is the most dominant native fish group within the Subtropical Desert Ecoregion. Vegetation types that are proposed for treatments include perennial graminoid communities, evergreen shrublands, and evergreen woodlands. Fire treatments would predominately occur in evergreen shrubland and perennial grassland communities in the Subtropical Desert Ecoregion.

Like the perennial graminoid grasslands in the Pacific Northwest, the perennial graminoid grasslands of the Lower Colorado River Basin support sparse shrubs and low trees, and exist on a continuum with evergreen woodlands. As a result, the general effects of fire on fish communities found within perennial graminoid grasslands and evergreen shrublands in this region would be largely the same as those described for fish in perennial graminoid and evergreen shrubland communities in the Subtropical Steppe and Temperate Steppe ecoregions of the Pacific Northwest.

The effects of prescribed fire to fish in evergreen woodland (pinyon-juniper) communities in this region would be similar to those discussed for evergreen

woodland (pinyon-juniper) communities in the Temperate Desert Ecoregion of the Upper Colorado River Basin below.

Upper Colorado River Basin

Evergreen forests of the Rocky Mountains have historically had variable fire regimes, ranging from frequent, low severity understory burns in ponderosa pine forests to infrequent, stand replacing fires in lodgepole pine forests (Arno 2000). Fish in this region exhibit characteristics similar to those of fish in the Pacific Northwest. They are apt to seek refuge in waters unaffected by adjacent burning, leaving burned areas poorly stocked until conditions become favorable once again (Minshall et al. 1990; Riemann and Clayton 1997; Gresswell 1999).

Frequent or intense fires could harm fish populations by removing vegetative cover and facilitating erosion. The extent to which surface runoff would affect water bodies would depend on the rate and amount of vegetation recovery, the timing of the fires, and the surrounding gradient (the steeper the topography the greater the runoff). However, maintaining buffers between burned areas and the aquatic resources would ensure that effects from runoff would not be substantial.

Increases in water yield and surface water runoff within a watershed would be more dramatic immediately after a storm event. With the exposure of bare soils by fire, surface erosion could also increase. The increase in sedimentation into local streams could overload a channel and alter channel morphology, causing significant habitat changes for fish. Furthermore, heat from a fire can raise water temperatures to levels lethal to fish. After such fires, a lack of a riparian canopy would also expose fish to increased stream temperatures, potentially displacing local populations within an area.

Fish are apt to seek refuge in unaffected waters, leaving burned areas poorly stocked until conditions become favorable once again (Minshall et al. 1990; Riemann and Clayton 1997; Gresswell 1999). The short-term effects of fire on fish populations are a function of both the degree and duration of fire-caused changes in water quality and quantity, and the proportion of each inhabited stream network affected by burning.

Many areas occupied by fish (such as Gila trout and Lahontan cutthroat trout) in pinyon-juniper forests are under prescribed fire management that allows fires to burn in certain areas at certain times. Prescribed fires of low to moderate intensity that mimic natural fires are not likely to negatively affect fish populations within the areas proposed for burning, since these fires are unlikely to cause increases in stream temperature or turbidity, or increased streamflow during subsequent storms.

Any accelerated rates of runoff and sedimentation resulting from prescribed fires in upland areas would progressively diminish as these surrounding areas achieved proper functioning condition. Timing burns in these areas so that they occur during periods of little precipitation, and limiting the burning to areas designated outside of riparian areas, would reduce the effects of surface erosion and sedimentation entering aquatic habitats, reducing the effects to aquatic populations.

The general effects of prescribed fire to fish in evergreen shrubland communities of the Rocky Mountains would be similar to those discussed for evergreen shrubland communities in the Pacific Northwest.

California

Fire treatment in the California hydrologic region would be directed at evergreen forests and evergreen woodlands. Fish habitat characteristics in this area are very similar to those observed in the western Pacific Northwest (as discussed above). Evergreen forests in this region historically had an understory fire regime or a mixed severity fire regime, and are presently at risk for high-intensity, stand-replacing crown fires due to large fuel accumulations.

Streams and rivers throughout the evergreen woodlands (oak woodlands) in this ecoregion are found at low elevations, and are used for rearing and foraging, rather than spawning, by salmonids (USDA Forest Service 2002a). Oak woodlands historically supported frequent, low intensity fires, which helped to maintain open stands with a grassy understory. Large oaks would be unlikely to be harmed during a low intensity fire, so that riparian areas and canopy coverage of water bodies would remain intact.

A concern within oak woodlands is the potential for erosion after a fire. High intensity fires can cause changes in soil structure that may exacerbate erosion problems (Neary et al. 1999), which can result in sediment from burned slopes clogging streams and reducing water quality. Oak woodlands typically occur in low gradient areas, so the potential effects to fish

from surface erosion from these habitats would be minimized. The reduced potential for surface erosion effects, combined with the low severity of prescribed fires, would minimize effects to fish within the project area.

The effects of prescribed fire to fish in evergreen shrublands of the Subtropical Desert Ecoregion would be similar to those discussed for evergreen shrubland in the eastern Pacific Northwest. In many areas of the Mojave and Sonoran deserts, plant communities are too sparse during most years to adequately carry a prescribed burn. Therefore, fire treatments would not be suitable for these areas, and fish would not be affected from prescribed fire in this region.

Missouri River Basin

The Missouri River Basin is predominantly in the Temperate Steppe Ecoregion. Basin vegetation types that would likely receive fire treatments in this ecoregion include evergreen forests, evergreen shrubland, and perennial graminoid communities. The general effects of fire on fish and other aquatic organisms found within these communities would be very similar to those observed in the eastern Pacific Northwest.

Effects of Mechanical Treatments

The effects of mechanical treatments on fish and other aquatic organisms would be related to the types and amounts of soil disturbed and vegetation removed, proximity of the treatment to water, and potential for equipment fuel and lubricant spills to enter the water. Mechanical methods are appropriate for vegetation treatments near water in all ecoregions where a high level of control over vegetation removal is needed, the risks to aquatic organisms from the use of fire and herbicides are great, and residual vegetative cover is needed to minimize soil erosion.

A number of mechanical techniques are used to control aquatic vegetation. Mechanical harvesters are used to cut and collect aquatic plants. These machines can cut the plant from 5 to 10 feet below the water surface and may cut an area 6 to 20 feet wide. Harvesters can open up areas, but can also fragment and spread aquatic vegetation to new areas. In addition, harvesters may affect fish and other aquatic organisms by removing them with harvested material. Cutting plant stems too close to the bottom can result in resuspension of bottom sediments and nutrients (Madsen and Stewart 2004).

Weed rollers, which can be up to 30 feet long, compress the sediment and plants in an area. Frequent use allows only a small amount of invasive vegetation growth, but may disturb bottom-dwelling organisms and spawning fish. A rotovator is similar to an underwater rototiller, and functions to dislodge and remove plants and roots. Since the rotovator greatly disturbs the sediment, there is concern that use of the equipment can: 1) resuspend contaminated sediments; 2) release nutrients absorbed or precipitated in the sediment (e.g., phosphorus); 3) adversely affect benthic organisms; or 4) affect fish spawning areas.

Mechanical treatments used in upland areas, such as blading, tilling, and grubbing would likely disturb soil, which can degrade aquatic habitat if carried in stormwater runoff. Sediment entering stream channels can affect channel shape, stream substrate, fish habitats, and the structure and abundance of local fish populations. To reduce effects, the BLM would limit blading to relatively level areas, and would reseed bladed and grubbed sites to prevent runoff and erosion.

Chaining, roller chopping, and mowing would leave plant debris on the surface, which would aid in the control of erosion. Leaving a vegetated buffer between the treatment area and water could also reduce the risk of sediments entering water.

Alaska and the Pacific Northwest

No mechanical treatments are scheduled to occur in the Tundra and Subarctic ecoregion. In the Marine and Temperate Steppe ecoregions of the Pacific Northwest, mechanical treatments would occur predominantly in mixed evergreen/deciduous forests and evergreen forests, and would potentially affect salmonid species. Treatments could involve thinning of spruce, aspen, and poplar forests to reduce hazardous fuels. Small streams are responsible for a high proportion of salmonid production, but are very responsive to alterations by forest management activities. Treatments within the riparian zone of small streams would be expected to increase light availability to aquatic habitats, but decrease the available organic matter entering the stream. Therefore, thinning along these streams could increase water temperature, and reduce food (i.e., macroinvertebrates) availability and woody debris input. The overall effect of mechanical treatments within the riparian zone would be positive, as this treatment would be selective, creating openings in the canopy and enhancing primary production, while ensuring continued woody debris input and suitable rearing habitat.

In the eastern Pacific Northwest, most of the mechanical treatments in evergreen shrubland would involve tilling or plowing of sagebrush, followed by seeding or drilling. Other mechanical treatments, such as mowing, chopping, and chaining, would also be used, but to a lesser extent. Treatments would target woody species (e.g., big sagebrush, rabbitbrush, and greasewood), with the goal of encouraging certain species of perennial bunchgrasses, forbs, and shrubs. Plowing would be used in areas with little herbaceous understory, where soil disturbance would help prepare the seedbed for revegetation.

Removal of vegetation could temporarily increase surface erosion into nearby streams. Increases in water yield and surface water runoff within a watershed would be more dramatic immediately around storm events. The increase in sedimentation into local streams could overload a channel and alter channel morphology, causing significant habitat changes for fish. However, as a result of tree removal, many native perennial grass species, forbs, and shrubs would increase on the site (Clary 1971, Jacobs and Gatewood 1999). Grass production generally doubles after sagebrush removal, because the cover of sagebrush is reduced and soil nutrient and water availability is increased (Sturges 1975). With the introduction of these grasses, runoff and erosion into nearby waterbodies would be minimized.

The Arid Environment

The general effects of mechanical treatments on fish and other aquatic organisms in sagebrush areas in this region would be largely the same as the effects on these organisms in the sagebrush areas of the Pacific Northwest. Removal of vegetation could temporarily increase surface erosion into nearby streams or vernal pools. Increases in water yield and surface water runoff within a watershed would be more dramatic immediately around storm events. With the exposure of bare soils by mechanical treatment, surface erosion could also increase. Because of the extremely low and irregular rainfall of this region, increase sedimentation in pools or streams from mechanical treatments would not be significant to fish.

In the Subtropical Desert Ecoregion of the Lower Colorado River Basin, some mechanical treatments are likely to occur in evergreen and deciduous shrublands. Because of the extremely low and irregular rainfall of this region, increased sedimentation in pools or streams from mechanical treatments would not substantially alter aquatic habitats. Many trout species in this region occur in high elevation habitats that consist of small headwater streams with limited pool availability and low base flow. Removal of canopy vegetation could alter the diversity of macroinvertebrates available for trout to feed upon.

Upper Colorado River Basin

Mechanical treatments in pinyon-juniper woodlands would primarily consist of thinning and machine piling of debris, as well as chipping/shredding and chaining to reduce the occurrence of pinyon and juniper species on sites they have invaded. Any accelerated rates of runoff and sedimentation from upland areas as a result of mechanical treatments would progressively diminish as these surrounding areas achieved proper functioning condition. Timing burns in these areas so that they occur during periods of little precipitation, and limiting the burning to areas designated outside of riparian areas would reduce the effects of surface erosion and sedimentation entering aquatic habitats, reducing the effects to aquatic populations.

The warmer and wetter conditions in the Upper Colorado River Basin would likely result in a more favorable vegetation response following treatment compared to similar plant community types in the lower Pacific Northwest, Great Basin, and Lower Colorado River hydrologic regions, reducing the longevity of the effects.

Effects to trout species at high elevations from mechanical treatments would be similar to those for fish populations in evergreen forest and woodland communities in the Temperate Steppe Ecoregion in the Pacific Northwest and Missouri.

California

Mechanical treatments in oak woodlands would remove conifers but stimulate the growth of understory forbs and grasses. These treatments would reduce canopy coverage, increasing the amount of sunlight reaching streams and reducing food availability. The general effects of mechanical treatments on salmonid populations in mountainous area and evergreen forests in this region would be largely the same as the effects on salmonid populations in the Pacific Northwest.

Missouri River Basin

Mechanical treatments in forest communities in the Missouri River Basin would largely consist of thinning

to reduce the density of trees and the accumulation of understory fuels.

Many of the rivers in this basin historically carried heavy silt loads, collected from tributaries in the northern part of the drainage. Using mechanical treatments in this area could increase surface erosion in nearby water bodies. Fish such as sturgeon and sicklefin chub are suited to turbid and dynamic conditions historically observed throughout this area, and changes to instream sedimentation would have little effect on these species.

Effects of Manual Treatments

Manual treatments, which tend to be more selective and involve smaller treatment areas than other methods, would be less likely to affect aquatic organisms than other methods. Hand pulling and hand cutting are the two primary methods used to remove invasive aquatic vegetation. During hand pulling, the whole plant should be removed, and the process must be repeated often to control regrowth. When hand pulling, the entire root system and all fragments of the plants must be collected or plant and root fragments may result in additional growth of the species. Hand cutting is done with both powered and non-powered tools and is generally appropriate for small patches of vegetation in water that is less than 4 feet deep. As with hand pulling, vegetation can become fragmented and spread to other portions of the lake or stream. Removing aquatic plants may also result in increased shoreline erosion, as the roots are no longer present to stabilize the soils and dampen wave action. Replanting disturbed areas with native vegetation can help reduce or correct this problem (Madsen and Stewart 2004).

In most cases, unwanted vegetation near a stream or wetland could be removed without disturbing more desirable vegetation. Typically, plant debris would be left in place. Fuel and lubricant spills could occur during the use of chainsaws and trimmers. However, these spills would be small and, in most cases, easily cleaned up before they spread to aquatic bodies.

Effects of Biological Treatments

Approximately 9,400 acres of wetland and riparian habitat would be treated using biological control methods. Nearly all acres would be treated using insects. Most of the acres treated would occur in the Temperate Steppe Ecoregion. Approximately 317,000 acres of upland habitat would be treated and livestock would be used for about 60% of treatments; insects and pathogens would be used to treat the remaining acreage.

Containment by Domestic Animals

Although livestock can be used to control vegetation, they can also potentially have additional effects on wetlands, riparian areas, and aquatic organisms. The degree of effect would be dependent on the duration and intensity of grazing. Removal of riparian vegetation by livestock has led to stream channels that are wider and shallower than streams in ungrazed areas (Hubert et al. 1985; Platts and Nelson 1985), although this is not always the rule (George et al. 2002). With increasing width and water depth, streams become warmer, and cold-water species are displaced by more tolerant, warm-water species.

There may also be some direct effects on aquatic organisms as a result of livestock wading in streams. Animals defecating into aquatic systems could create water quality conditions that cause injury or mortality to aquatic organisms.

Biological Control Agents

Biological control can involve the use of 1) host-specific organisms, 2) opportunistic native or exotic pathogens or insects, 3) general feeders, such as grass carp that control most types of aquatic vegetation, and 4) native herbivores. A disadvantage of biological control is that it can take many years, and thus is most effective in low-priority areas, where other vegetation control methods are cost prohibitive or are not practical.

Biological treatments using insects or plant pathogens would have little or no effect on aquatic organisms, but could alter their habitats by killing or harming host plants. In most cases, these biological treatment organisms would be released on foot or from ATVs, and vegetation weakened or killed by these organisms would remain in place, resulting in little soil disturbance in the treatment area.

Effects of Chemical Treatments

The use of herbicides to control noxious and nuisance aquatic plant species represents one of the most widely known and effective management options available. Herbicide control of invasive aquatic weeds is often the first step in a long-term integrated control program. Herbicides that could be used by the BLM in aquatic and riparian areas include 2,4-D, glyphosate, imazapyr, and triclopyr. In addition, the BLM proposes to use

diquat and fluridone, and has prepared an HHRA and ERAs to address the risks associated with using these herbicides (see Appendixes B and C in the PEIS).

The remaining herbicides currently approved for use, or proposed for use, by the BLM would be used on uplands. Herbicides used to treat terrestrial vegetation on public lands would have the potential to enter water bodies and affect aquatic organisms through direct application into aquatic environments (of herbicides approved for use in these habitats), through accidental spraying (via aerial or ground applications), or through the movement of herbicides from upland areas to nearby water bodies in stormwater runoff. At low concentrations, herbicides would typically have little or no effect on aquatic organisms. At moderate concentrations, herbicides may not kill fish or other aquatic organisms, but could be detrimental to the survival, growth, reproduction, or behavior of certain organisms. At high concentrations, herbicides can be lethal to aquatic organisms.

Ecological risk assessments were conducted by the BLM and Forest Service to evaluate the risks to fish and other aquatic organisms from the use of 18 herbicides. The results of these assessments, including study methodology, herbicide mode of action, exposure scenarios, and toxicity characteristics for each herbicide, are summarized in the PEIS.

The purpose of the risk assessments was to identify the chronic and acute toxicity of herbicides to salmon and other aquatic organisms for typical exposures (runoff from nearby rangeland) as well as worst-case exposures (direct spray of water or accidental release of tank load from helicopter). For streams, the assessment assumed that fish reside in a small stream with limited water volume and dilution potential, characteristics that are typical of streams used by salmon for spawning and early rearing habitats. For each herbicide, the concentration of active ingredient likely to be found in the water under each exposure scenario was calculated, and then compared to the concentration that has been shown in scientific studies to be harmful to aquatic organisms, to determine whether the herbicides could affect aquatic species.

The extent of disturbance to fish and other aquatic populations caused by herbicide treatments would vary by the extent and method of treatment and chemical used. Herbicides could come into contact with and affect fish and aquatic invertebrates through drift, runoff, wind transport, or accidental spills and direct spraying. Potential effects include mortality, reduced productivity, abnormal growth, and alteration of critical habitat. In general, risk to aquatic invertebrates and fish from spray drift is greater with smaller buffer zones and application rates, and with application from greater heights (i.e., aerial application or ground application with a high boom). Risk to aquatic invertebrates and fish from surface runoff is influenced by precipitation rate, soil type, and application area. Under most accidental scenarios (direct spray or spill), there would be risks to aquatic invertebrates and fish. Furthermore, persistent herbicides adsorbed to soil particles could be carried off site by wind or water, affecting fish and aquatic invertebrates in nearby aquatic areas. However, in this analysis, wind transport of herbicide particles posed no risk, or only a low risk (diuron), to fish under the evaluated scenarios. Application rate was a major factor in determining risk, with scenarios involving maximum application rates most likely to pose a risk to fish.

The risk characterization process of the ERA suggested that chlorsulfuron, dicamba, diflufenzopyr, Overdrive®, and sulfometuron methyl are very safe to fish and aquatic invertebrates, as no risk was predicted for exposures involving these herbicides under any of the evaluated scenarios, including accidental direct spray and spill scenarios. In addition, imazapic does not pose a risk to fish or aquatic invertebrates, except when directly sprayed over a stream at the maximum application rate. There is no risk to fish or aquatic invertebrates associated with off-site drift of bromacil or tebuthiuron. Diuron can present a moderate to high risk to fish and aquatic invertebrates under surface runoff scenarios, if applied at the maximum application rate. The aquatic herbicides (i.e., diquat, fluridone, and glyphosate) do present a risk (low to high) to fish and aquatic invertebrates when applied to ponds and streams. This risk is greater for diquat than fluridone, which at the typical application rate only poses a risk to aquatic invertebrates in streams (aquatic herbicides are not typically applied to streams; therefore, this is an accidental scenario).

Beneficial Effects of Treatments

About two-thirds of wetland habitats and one-half of stream habitats in the western U.S. are considered by the BLM to be properly functioning. Nearly 100% of the streams and wetlands in Alaska are properly functioning. Much of the habitat management for fish in the western U.S. is guided by several policy documents. Prior to the 1990s, habitat management for fish and other aquatic organisms was primarily addressed in land

use plans. In 1991, the Columbia River Basin Anadromous Fish Policy, a policy for anadromous fish protection in the Columbia Basin, was implemented. The PACFISH strategy, developed in 1995, outlines a strategy for anadromous fish habitat management, while the inland native fish strategy (INFISH), also implemented in 1995, provides guidance on management of resident fish outside of anadromous fish habitat in the Pacific Northwest. In addition, numerous Biological Opinions prepared by the USFWS and NMFS have helped to shape wetland and riparian habitat management.

Overfishing, mining, timber harvest, livestock grazing, agriculture, residential and commercial development, road building, and dam development and hydropower operations have been the primary factors contributing to the loss and modification of fish habitat in the western U.S. In addition to outright loss of habitat, turbidity, flow alteration, and high water temperatures are the primary factors that limit habitat quality for fish and other aquatic organisms on public lands. Habitat loss has not been uniform across the West; in wilderness and other protected areas, high quality habitat for fish and other aquatic organisms can still be found (USDA Forest Service and USDI BLM 2000b).

Of special concern to habitat managers in the West is the potential for a catastrophic event to occur, such as a wildfire or drawdown of water in a vernal pool, which would remove all of a species' habitat or severely limit the species' ability to move to more suitable habitat.

The BLM's highest priority is to use vegetation treatments to restore high priority subbasins within key watersheds to benefit fish and other aquatic organisms. Over the short term, adverse effects to aquatic organisms from vegetation treatment activities proposed by the BLM would occur, but treatments would lead to improved conditions for aquatic species over the long term. The eventual growth of desirable vegetation in treated areas would moderate water temperatures, buffer the input of sediment and herbicides from runoff, promote bank stability, and contribute woody debris to aquatic bodies. Ongoing efforts by the BLM to enhance riparian vegetation would also help to increase the number of miles of BLM-administered streams that are classified as "Proper Functioning."

Invasive aquatic vegetation spreads and rapidly colonizes water bodies. The canopy formed by invasive species can displace native species and alter animal communities in littoral zones and wetlands. An overabundance of an invasive species can create a visual barrier that interferes with the ability of larger predatory fish to feed. Reduced predation causes slower fish growth, favors smaller-sized fish, reduces the number of larger, harvestable fish, and results in poor quality sport fishing.

Removal of dense aquatic vegetation can lead to improved habitat for fish and other aquatic organisms (Dibble et al. 2004). Promotion of conditions that favor diverse aquatic plant communities increases the habitat complexity of aquatic systems, thereby providing a refuge for prey species and young predator species. Plants also provide habitat for invertebrates that are the food of many fish. Most fisheries studies have concluded that a moderate amount of vegetation is optimal for fish habitat. However, if a monoculture of an invasive species establishes that covers more than 85% of the pond or stream, most fish decrease in size and number. Thus, mechanical, manual, and herbicide treatments, and in some cases biological treatments, that reduce the amount of invasive aquatic vegetation would improve habitats for fish and other aquatic organisms. Because of concern over the spread of invasive aquatic species, two of the four new herbicides proposed for use by the BLM, fluridone and diquat, were chosen for evaluation based on their effectiveness against aquatic and riparian invasive species.

Vegetation treatments that restore native plant communities and ecosystem function would reduce sediment input into streams by improving degraded areas and providing suitable vegetative cover between areas of erosion and streams and other aquatic bodies (USDA Forest Service and USDI BLM 2000b). Improved cover adjacent to aquatic habitats would shade the water and reduce water temperatures. Removal of invasive vegetation, such as pinyon and juniper, could increase streamflow, while replacement of invasive species with native grasses, forbs, shrubs, and trees would stabilize streambanks and moderate streamflows. Furthermore, replacement of annual and perennial weeds and other invasive species with shrubs and trees would also increase the amount of woody debris in water bodies that can be used as habitat by fish.

Effects of Fire Treatments

Vegetation treatments that reduce hazardous fuels would benefit aquatic animals by reducing the chances that a large, uncontrolled wildfire would destroy a large amount of high quality aquatic habitat. Fire can adversely affect aquatic organisms by degrading water

quality and raising water temperature. However, effects would be less severe for prescribed fires than wildfires.

Prescribed fire treatments could benefit salmon species by reducing hazardous fuel loads, and therefore the risk of a destructive high intensity wildfire. In many cases, pre-treatment fuels reductions (e.g., thinning and pile burning) would be necessary to reduce the severity of prescribed burns near or within riparian zones.

Effects of Mechanical and Manual Treatments

Mechanical methods are appropriate for vegetation treatments near water where a high level of control over vegetation removal is needed or the risks to aquatic habitats from the use of fire and herbicides are great. These treatments are especially effective in treating sensitive habitats or habitats that support sensitive fish species.

Manual treatments, which tend to be more selective and involve smaller treatment areas than other methods, would be less likely to affect wetland and riparian areas than the other methods.

Effects of Biological Treatments

Although most biological control would be accomplished using insects, there is at least some potential to use livestock to control riparian vegetation. Wetland grazing has been shown to provide desirable plant response when applied under the right conditions. Seasonal exclusion of cattle has been proven to be an effective management tool in regulating soil and vegetation effects. With the right timing and amount of grazing pressure, invasive plants such as reed canarygrass, river bullrush, and cattails can be severely injured. The extensive root systems of such species are shredded by the cow hooves. Brush and weed management is the greatest potential benefit that managed grazing provides to riparian areas. Goats and sheep have long been used for weed control. The use of goats in areas infested with leafy spurge has proven to be successful. Goats, which show a strong preference for spurge, are less costly than chemical control measures.

If treatments using insects and pathogens are successful, the plant community near the water body should improve and provide good habitat for aquatic organisms. It is possible that some biological treatment organisms could provide food for fish. When used in conjunction with other treatment methods, such as mechanical and chemical methods, biological control can provide effective long-term control of unwanted vegetation. Grass carp are effective in controlling water-thyme and other plant species. Weevils (*Neochetina* spp., *Hydrellia* spp.) are effective in controlling water hyacinth and water-thyme. Several species of weevils and leaf beetles (loosestrife root weevil, black-margined loosestrife beetle, golden loosestrife beetle, blunt loosestrife seed weevil, and salvinia weevil) have been used to control purple loosestrife and giant salvinia (Confrancesco et al. 2004).

Effects of Chemical Treatments

This risks and benefits of herbicide treatments to aquatic organisms are discussed in more detail in the PEIS. Each of the currently available and new herbicides evaluated in the PEIS has different properties (e.g., mode of action), is suggested for different uses, and is most effective/least risky in different scenarios. The more herbicides available for use, the easier it is to select one or more that would result in the least risk to fish and aquatic invertebrates for specific aquatic applications or terrestrial applications near waterbodies.

The BLM's ability to use four new chemicals (fluridone and diquat for aquatic applications, and imazapic and Overdrive® for terrestrial applications) would allow the BLM to use herbicides that have less risk to fish and other aquatic organisms than herbicides that are currently available for use by the BLM.

Effects to Special Status Fish and Other Aquatic Organisms

Public lands in the western U.S. support over 100 species of aquatic animals that have been given a special status based on their rarity or sensitivity. Included are 59 species of fish, 13 species of aquatic mollusks, and 6 species of aquatic arthropods that are federally-listed as threatened or endangered, or are proposed for federal listing. Some of these species have habitat requirements that have been or are being altered or reduced by invasions of non-native plant species. Populations of non-native aquatic species and riparian weeds may alter aquatic habitats, making them less suitable for special status fish and aquatic invertebrates. The *Final Programmatic Biological Assessment Vegetation Treatments on Bureau of Land Management Lands in 17 Western States* (USDI BLM 2007b) provides a description of the distribution, life history, and current threats for each federally-listed species, as well as species proposed for listing. The BA also discusses the risks to special status fish and aquatic

invertebrates associated with vegetation treatments proposed by the BLM.

In general, the potential effects to special status fish and aquatic invertebrate species from the proposed vegetation treatments would be similar to those described for fish and aquatic vertebrates as a whole in the previous section. However, the rarity and sensitivity of special status species and their habitats make them more likely to be affected by disturbances associated with treatments. For many species, additional mitigation is required. In addition, populations of special status species may in some cases benefit more from fuels reduction and control of non-native species than aquatic animals with secure populations.

Standard Operating Procedures

The BLM would implement SOPs to minimize the risks to special status fish and other aquatic organisms from vegetation treatments (see Table 2-5). Examples of SOPs include surveying for species of concern if the project may impact federally-listed species; minimizing direct impacts to species of concern from fire treatments, unless studies show that these species will benefit from fire; minimizing the use of ground-disturbing equipment near species of concern; and using temporary roads when long-term access to treatment sites is not required.

Adverse Effects of Treatments

A general reduction in the plant biomass of riparian areas, which could occur by any of the treatment methods proposed for use on public lands, can have multiple consequences for aquatic species, including an increase in water temperature and sedimentation, and a decrease in water storage capacity. Riparian cover provides shade to aquatic habitats, which cools water temperatures, and reduces the extent of water temperature fluctuation. In addition, riparian vegetation stabilizes the soil on banks, preventing erosion and sedimentation into streams and other aquatic habitats, and intercepts rainfall to reduce overland flow. Riparian vegetation also increases habitat quality by buffering streams from incoming sediments and other pollutants, building a sod of herbaceous plants to form undercut banks, increasing habitat complexity, and increasing terrestrial invertebrate prey for fish species (Platts 1991).

Increased sedimentation entering aquatic habitats as a result of destabilized streambanks and increased erosion can cover spawning/rearing areas, thereby reducing the survival of fish embryos and juveniles. Sedimentation can also fill pool habitats, making them unusable by fish and other aquatic organisms. A number of sublethal effects to aquatic species may also occur as a result of sedimentation, including avoidance behavior, reduced feeding and growth, and physiological stress (Waters 1995). Over the long-term, increased sediment loads reduce primary production in streams. Reduced instream plant growth, combined with the reductions in riparian vegetation, can limit populations of terrestrial and aquatic insects, which also serve as food sources for many special status fish species.

Removal of large amounts of riparian vegetation, while potentially causing a surge of nutrients into streams, can alter the nutrient dynamics of the aquatic habitat. In areas where riparian vegetation has been lost to fire, a shift in energy inputs from riparian organic matter to primary production by algae and vascular plants have been predicted (Minshall et al. 1989) and observed (Spencer et al. 2003). This change in a stream's food web could alter the composition of food and thus energy sources that are available to special status fish and other aquatic organisms.

The increased solar radiation that results from the loss of streamside or poolside vegetation causes temperatures, light levels, and autotrophic production (plants and algae) to increase. The resulting effects on some special status species, and particularly salmonids, may include reduced growth efficiency, an increased likelihood of succumbing to disease, and an increase in food production.

Numerous special status aquatic animals are most threatened by changes in water levels and quality associated with development, upslope land use practices, and groundwater pumping, and the expansion of non-native fish populations. For most of the special status aquatic animals discussed in the BA, invasions of non-native plant species into riparian and aquatic habitats were not listed as threats to the species' survival. For these animals, health risks and effects to aquatic habitats associated with vegetation treatments could outweigh any habitat improvements resulting from minimized weed infestations. In addition, some treatments could have short-term adverse effects on special status fish and aquatic invertebrates by reducing the overall cover of riparian vegetation that regulates water temperature through shading. It is also likely, however, that the weed infestations (if present) in or near the aquatic habitats that support some of these species do not currently require treatments under the BLM's vegetation management programs.

Effects of Fire

The effects of fire on water conditions, such as heating and chemical changes, would be short term in duration. However, a temporary impairment of water quality in habitat occupied by special status fish and other aquatic organisms could have lasting population-level effects if individual animals were killed or became more susceptible to predation as a result.

Other short-term effects on water quality as a result of fire treatments would be expected to pose a greater risk to special status fish and other aquatic organisms than species with more secure and extensive populations. The potential increase in water temperature and influx of sediments, ash, and chemicals (e.g., those associated with foam lines) resulting from removal of vegetation in riparian areas could reduce the vigor of special status species populations, particularly if all of a species' limited habitat were affected.

Furthermore, use of water from aquatic habitats that support special status species for creating wet lines and extinguishing hot spots could adversely affect those habitats, particularly in arid climates or during dry seasons, when water is limited. Taking water from aquatic habitats with special status species could also result in inadvertent entrainment and/or harassment of those species, which could have lasting effects on sensitive populations.

Effects of Mechanical Treatments

As discussed for aquatic animals in general, use of heavy equipment in riparian areas could physically degrade aquatic habitats through bank collapse, use of heavy vehicles directly in the water, and leaking of equipment fuel or lubricants into the water. For some special status species, loss of even a few individuals, or destruction of even a small area of habitat could substantially increase the susceptibility of the population to future extirpation. Risks would be greatest if the treatments occurred over the entire area occupied by a population.

As discussed previously, aquatic habitats would likely be altered by mechanical treatments in adjacent riparian and upland habitats. The degree of alteration would depend on the size and intensity of the treatment, as well as site conditions and other factors. Treatments resulting in sedimentation into aquatic habitats through soil disturbance and removal of stabilizing vegetation would be expected to affect populations of special status species, especially those that require clear water. Although most effects would be short term in duration, lasting effects to species with sensitive populations could occur. Furthermore, removal of plants and woody material from riparian areas could result in a future loss of coarse woody debris, which would have a lasting effect on special status species that use such debris for rearing habitat, substrate (in the case of aquatic invertebrates), and to hide from predators. These effects to habitats would be greatest if woody vegetation within the distance of one tree height away from the channel was removed (National Fire Plan Technical Team 2002).

Effects of Manual Treatments

Although some removal of vegetation would occur during manual treatments, it is unlikely that loss of riparian vegetation would be as extensive as that occurring during fire or mechanical treatments, since manual treatments are economically feasible only for limited weed infestations. Manual treatment methods are typically associated with minimal environmental effects, and as such are often appropriate for sensitive habitats, such as riparian areas. Some soil disturbance would occur during the removal of plants from the soil, but it would not be widespread and should not have a major effect on aquatic habitats. Provided manual methods are used appropriately (e.g., for small infestations and where native vegetation will replace the pulled weeds), effects of this treatment method should be beneficial to special status fish and aquatic invertebrates.

Effects of Biological Control Treatments

Containment by Domestic Animals. As discussed previously, the potential for weed containment by domestic animals to affect fish and other aquatic organisms is dependent on the size of the treatment area, the number of animals involved, the duration of the treatment, and how close to the water animals are allowed. Special status species would likely be more sensitive to water quality degradation from associated sedimentation or inputs of feces into the water than species with secure populations. Though most effects would be short term, they could have lasting effects on special status fish and aquatic invertebrates. If animals were allowed to enter the water occupied by special status species, some mortality or injury could occur, primarily to eggs and pre-emergent fry, but also adults of smaller fishes and other aquatic organisms. For species with small, isolated populations, increased risks of extirpation could result.

Special status fish and other aquatic organisms could also experience long-term effects from any structural changes to habitat resulting from intensive or repeated weed containment scenarios occurring in or near their habitats (e.g., widened or incised stream channels, streambank collapse, lowered water table, or loss of pools or undercut banks). Special status species often have very particular habitat requirements that contribute to their limited distribution. Loss of any of these habitat features could lead to extirpation of a population, with risks increasing the greater the portion of habitat affected.

Other Biological Control Agents. Use of biological control agents in aquatic and riparian habitats would result in the loss of some vegetation, so the general effects discussed above could potentially occur. Unlike under other treatment methods, however, the loss of vegetation resulting from biocontrol agents would be gradual, and therefore less likely to have a noticeable effect on aquatic systems. Some soil disturbance resulting from workers releasing agents in riparian areas could occur, but would be unlikely to have substantial effects on aquatic habitats.

Biological control agents would be thoroughly tested, and permitted by the USDA Animal and Plant Health Inspection Service prior to release. Despite these safeguards, there is always a risk that the release of an organism into a habitat in which it does not normally occur can result in unforeseen ecological repercussions. These unanticipated effects of biological control agents would be impossible to predict, although the appropriate precautions would be taken to prevent their occurrence.

Effects of Chemical Treatments

Risks to special status aquatic animals from herbicide treatments could be greater than risks to aquatic species with more secure populations. Diquat could affect special status fish and aquatic invertebrates during a normal application to an aquatic habitat. Normal applications of 2,4-D and imazapyr would not pose a risk to special status fish or aquatic invertebrates.

Terrestrial herbicides with the greatest likelihood of affecting special status aquatic animals as a result of a spill, drift, accidental direct spray into an aquatic habitat, or surface runoff are diuron and picloram. According to ERAs, there would be no risks to fish or aquatic invertebrates associated with chlorsulfuron, dicamba, diflufenzopyr, imazapic, Overdrive®, or sulfometuron methyl.

Beneficial Effects of Treatments

The invasion and spread of non-native plant species into aquatic and riparian habitats may affect certain populations of special status fish and other aquatic organisms. An overview of the ways in which non-native aquatic and riparian plants may affect aquatic habitats is presented earlier in this section. As discussed in the BA, numerous special status fish species are threatened by changes in water quality and flow, which may result from weed infestations. Salmon, for example, require a high level of dissolved oxygen, which is reduced when aquatic weeds such as Eurasian watermilfoil and water-thyme invade an aquatic system. A decrease in dissolved oxygen associated with the encroachment/excessive growth of vegetation has also been listed as a threat to the Foskett speckled dace in south-central Oregon (USFWS 1985) and the unarmored threespine stickleback in southern California (NatureServe Explorer 2001). For species such as these, treatments to reduce coverage of non-native plant species in aquatic and riparian habitats would likely improve habitat over the long term.

Provided short-term adverse effects to special status aquatic animals were avoided, a well-managed prescribed fire could have a beneficial effect on special status aquatic species over the long term, as a result of improved and rejuvenated habitat, as well as increased productivity (Minshall and Brock 1991, Burton 2000). Over the long term, there could also be an increase in populations of special status species as a result of a more healthily functioning ecosystem. This benefit would especially be true for riparian habitats that were historically subject to frequent, low intensity burns. Both the condition of the site prior to burning and the intensity of the burn would influence whether the end result of the fire was beneficial. Even a high intensity burn could eventually have a beneficial effect on riparian/aquatic habitats, especially if site restoration measures were followed post-burn.

Treatments would help to restore natural fire regimes and reduce the risk of wildfire. Wildfires influence aquatic systems by heating water or changing its water chemistry. Indirect effects include changes in hydrologic regime, erosion, debris flows, woody debris loading, and riparian cover. Wildfires kill fish and have caused local extinctions. A study of bull trout and redband trout on the Boise National Forest showed that wildland fires resulted in extensive direct mortality, as well as increased erosion, debris torrents, and other habitat effects. Treatments that minimize the threat of wildfire would reduce these types of risks to fish.

Interestingly, the numbers of fish on the affected stream reaches returned to near normal within 3 years after the fire (Rieman et al. 1997). This may be because large disturbances have been common in these systems in the past (Meyer and Pierce 2003 *in* Rieman et al. 2005). Fire can contribute coarse woody debris and sediment to streams that provide structure (Bisson et al. 2003 *in* Rieman et al. 2005). Although it opens the canopy, resprouting and increased growth of riparian vegetation can offset shade losses because of canopy reduction, and provide a source of insects into the stream.

Wildlife Resources

Wildlife occupies widely diverse habitats in the western U.S., and serves many different roles (e.g., herbivore, predator, scavenger). Many wildlife species can be found in several environments, but others are limited to one or two habitats. Species that are wide ranging and use several habitats are usually better able to adapt to change than species with narrow habitat requirements. As conditions worsen in one area, perhaps due to a large fire, they move to other areas. However, as animals move to a new area, the amount of food and other resources available to wildlife decreases per animal as the population in the area increases. Thus, a major habitat change in one area can indirectly cause a reduction in wildlife health and productivity, and potentially reduced habitat quality, in another area.

Species that depend on one or a few habitats are vulnerable to disturbance, and can become extinct as a result of extirpation from catastrophic wildfire or other major natural or man-made effects to habitats. Many of the species listed in the BA, which accompanies this PER, are restricted to small patches of habitat. Species with limited mobility are also susceptible to change.

Mobile species and animals that can use a variety of habitats usually move into other habitat types when change occurs. However, if change occurs across a broad area, as has occurred in sagebrush habitat in the Great Basin, even relatively adaptable and mobile species may decline in numbers. In addition, if habitats become fragmented, species populations may become isolated and unable to breed with other populations and exchange genetic material, which is often necessary to maintain small populations.

As a result of changes that have occurred on public lands and throughout the western U.S. from altered fire regimes, the spread of weeds and other invasive vegetation, and other human causes, habitat has declined for many wildlife species. Declines in habitat extent and quality during the past century are largely responsible for the listing of many species as threatened or endangered.

Scoping Comments and Other Issues Evaluated in Assessment

Respondents felt that the BLM should manage for biodiversity and identify specific sites that have high wildlife value. Other respondents wanted the BLM to address the habitat requirements of different wildlife species and the ways in which vegetation treatments would influence these habitats. The potential effects of treatments on ground-nesting birds were also mentioned as an important issue to consider. It was noted that burning may remove desirable habitat, and protecting biodiversity before and after fire was suggested. Some respondents felt that spring burning would harm wildlife, and that it is not consistent with natural fire regimes. Some concern was expressed that firelines might be used as vehicle routes and cause degradation of vegetation and wildlife habitat.

Numerous comments also promoted the idea that wildlife habitat improvement efforts should be directed at restoring habitat and natural ecological processes. Several respondents suggested that the role of keystone species, such as the prairie dog, pronghorn, and American bison, are important considerations. Respondents were also concerned about the impacts of treatments on habitat of wildlife used for subsistence (e.g., reindeer).

The protection of greater sage-grouse and their habitat was advised. It was noted that carefully applied herbicides may improve greater sage-grouse habitat. Comments also suggested that impacts to northern spotted owl habitat should be identified and addressed. It was noted that the maintenance of early-successional deciduous vegetation and a mosaic of vegetation types is important for most wildlife. One respondent suggested that the treatment of critical habitat areas would force wildlife to other areas, and wondered whether the BLM would also manage those areas. One respondent noted that aggressive tamarisk removal efforts in the Mojave River have killed wildlife in the past. Respondents also felt that impacts of treatments on soil and litter organisms, insects, and snag habitat should be analyzed.

Numerous comments encouraged the BLM to use this process as an opportunity for the recovery of the full

range of native species and ecosystems across the western states, including the greater sage-grouse, white-tailed and black-tailed prairie dogs, black-footed ferret, Columbia spotted frog, Washington ground squirrel, and wolves.

Resource Program Goals

The Wildlife Management program, a subprogram under the Wildlife and Fisheries Management program, is responsible for wildlife habitat management on public lands. The purpose of the program is to maintain and restore wildlife and their habitats by conserving and monitoring habitat conditions, conducting wildlife resource inventories, and developing cooperative management plans, while providing for environmentally responsible recreation and commercial uses. Management actions emphasize on-the-ground and in-the-water actions that measurably increase the health of wildlife populations and reduce the need to federally list species of wildlife. The program supports the BLM's strategic plan by improving the health of watersheds and sustaining biological communities. The overall goal is to restore and maintain proper functioning conditions in aquatic, wetland, riparian, and upland systems (USDI BLM 2006c).

Standard Operating Procedures

This assessment of treatment effects assumes that SOPs listed in Table 2-5 for vegetation and wildlife would be used to reduce potential unintended effects to non-target vegetation and to minimize harm and disturbance to wildlife. Effort would be made to protect beneficial habitat characteristics and to protect special status species and their habitats. These SOPs include minimizing treatments during nesting and other important periods for birds and other wildlife; minimizing burns immediately prior to important use periods, unless the burn is designed to stimulate forage growth; retaining wildlife trees and other unique habitat features, where practical; and designing chaining activities to provide the maximum mosaic of treated and nontreated sites. For biological treatments with domestic animals, grazing would be minimized where/when it could impact nesting and/or other important periods for wildlife, and where it would be likely to result in removal or physical damage to vegetation that provides critical sources of food or cover for wildlife. SOPs for herbicide treatments, which are summarized in Table 2-8 of the PEIS, include using herbicides of low toxicity to wildlife, where feasible, and conducting pre-treatment surveys for sensitive habitat and wildlife species of concern. To minimize the potential for adverse effects to amphibians, the BLM would limit the use of herbicides in areas occupied by amphibians; and would avoid using glyphosate formulations that include R-11, and either avoid using formulations with POEA or use the formulation with the lowest amount of POEA available.

Adverse Effects of Treatments

The extent of these disturbances would vary by the extent and type of treatment, as discussed in the sections that follow. Over the short term, fire and other treatments could make habitats less suitable for some wildlife species, requiring displaced wildlife to find suitable habitat elsewhere. If these habitats were already at or near capacity in the number of wildlife they could support, displaced animals might perish or suffer lower productivity. In many cases, the treatments would return all or a portion of the treated area to an early successional stage, favoring early successional wildlife species. In areas where fire suppression has historically occurred, vegetation treatments could benefit native plant communities by mimicking a natural disturbance component that has been missing from these communities. Treatments would also restore native vegetation in areas where weeds and other invasive vegetation have displaced native plant species. Wildlife that occurred historically in these areas would likely increase in numbers, while species that have adapted to the disturbed conditions would decline.

Approximately 15% of treatments would be specifically designed to benefit wildlife habitat, although nearly all treatments would provide some benefit to wildlife habitat. Most treatments would occur in the Temperate Desert (50% of all treatments), Temperate Steppe (28%), and Mediterranean (8%) ecoregions.

Effects of Fire Treatments

Approximately 63% of fire treatments would occur in the Temperate Desert Ecoregion to benefit greater sage-grouse and other sagebrush-dependent species. Twelve and 9% of treatments would occur in the Subarctic and Subtropical Steppe ecoregions, respectively. Nearly half (48%) of all fire treatments would occur in evergreen shrublands and 19% would occur in evergreen woodlands. Six percent of treatments would occur in evergreen forests and perennial graminoid communities.

The effects of fire on wildlife and other fauna have received considerable attention in recent years, and there is an increasing literature base available

documenting fire-wildlife relationships. Several references were used as primary sources to prepare this section: *Fire: Its Effects on Plant Succession and Wildlife in the Southwest* (Wagle 1981); *Final Environmental Impact Statement Vegetation Treatment on BLM Lands in Thirteen Western States* (USDI BLM 1991a); *Wildlife Habitat Management of Forestlands, Rangelands, and Farmlands* (Payne and Bryant 1998); *Wildland Fire in Ecosystems: Effects of Fire on Fauna* (Smith 2000); and *Terrestrial Wildlife and Habitat* (Anderson 2001).

Fire has influenced the composition, structure, and landscape patterns of animal habitat for millions of years, so it can be assumed that wildlife have coexisted and adapted to perturbations from fire (Lyon et al. 2000b). Fire is irreplaceable for many organisms, and aside from using livestock as a tool to enhance habitat, it is more practical to use, ecologically and economically, than other treatment methods (Payne and Bryant 1998). Fire has an ecological role in the development of most habitats. Fire changes the composition and distribution of vegetation, and generally improves the palatability and nutritional value of forbs, grasses, and some shrubs. Fire also promotes early-spring greenup, which is important to the nutrition of pregnant animals and young, and can remove dead and dying material that may limit access by wildlife to living vegetation (USDA Forest Service and USDI BLM 2000b).

Fire can kill and injure animals, although the number of wildlife killed by fires is probably a small proportion of most animal populations (Lyon et al. 2000a). Animals with limited mobility that live above ground are most vulnerable, but at times even large mammals are killed by fire, as evidenced by the Greater Yellowstone Area fires in 1988 that killed about 1% of the elk population (Singer and Schullery 1989). Fire may threaten a population if it is limited in size, range, or mobility, such as the extinct heath hen, whose demise might have been accelerated by scrub fires (Lloyd 1938).

Time of year of fire is an important variable in wildlife mortality. The eggs and young of birds are susceptible to fire, especially ground-nesting birds. The nesting season often coincides with the active period of plant growth, when moisture conditions are too wet to sustain prescribed fires. If a fire burns in a mosaic pattern, leaving some areas of vegetation relatively unscathed, some young may survive. The young of small mammals that build dens or nests near the ground, such as small rodents and hares, are susceptible to fire. Woodrats are particularly susceptible to fire mortality because of their reluctance to leave their houses even when a fire is actively burning (Simons 1991). Small mammals can often escape fire by going into burrows or hiding in rock crevices, under stumps or roots, or in large dead wood (Ford et al. 1999).

Fire regime and microsite characteristics can influence wildlife mortality from fire. Many desert and semi-desert habitats burned infrequently in the past because of sparse fuels. In these areas, patchy fire spread may have provided areas of unburned habitat where reptiles and small mammals could escape fire. Some amphibians and reptiles, in addition to small mammals, escape fire by burrowing into the soil or hiding under moist duff or leaves that burn less readily than drier forest or rangeland materials (Ford et al. 1999).

Wildlife that leaves an area due to fire may return soon thereafter if food or cover is available in unburned areas, or even in burned areas. For example, scavengers and predators will often return to a burned area to feed upon insects or other dead or dying animals harmed by fire. Geese often move into burned marshes while plants are still smoldering to feed on plant roots, while deer and other herbivores may return to a burned area after greenup. Other wildlife may emigrate until more suitable conditions return. A number of bird species show declines in numbers for several years after a burn, while numbers of other species increase. Caribou may avoid burned areas for 50 years or more until lichens, a preferred food, become reestablished in the new forest (Thomas et al. 1995).

Fire creates a mosaic of different kinds of vegetation (Mushinsky and Gibson 1991), with variability in size, composition, and structure of patches, as well as connectivity among patches. Within a large fire, there can be substantial variation in fire severity and many patches of vegetation may not burn, resulting in variation in plant mortality and perpetuation of the mosaic nature of the landscape (Gasaway and DuBois 1985, Smith 2000). Some areas will burn more intensely than others, influencing the nature of the vegetation that remains. When fire increases the heterogeneity of the landscape, some species of wildlife benefit from having increased opportunities to select from a variety of habitat conditions and successional stages.

Fire Effects by Ecoregion

Tundra Ecoregion. Fire use is not planned for the Tundra Ecoregion (Table 4-9), and prescribed burning is generally not recommended. If fire were to occur it would consist of wildland fire use for resource benefit.

As stated in the *Alaska Interagency Wildland Fire Management Plan* (Alaska Wildland Fire Coordinating Group 1998), "lightning caused wildland fires are an important component of the boreal forest and Arctic tundra ecosystems, and the complete exclusion of these fires is neither ecologically sound nor economically feasible."

The effects of fire on northern ecosystems were discussed under Vegetation in this Chapter. Enhancement of grasses and sedges using fire would benefit nesting shorebirds and waterfowl, and their young. Fire would also reduce cover and may make birds and small mammals more visible for snowy owl and other raptors, Arctic foxes, and other predators.

Subarctic Ecoregion. About 12% of proposed fire treatments would occur in this ecoregion. In the Subarctic Ecoregion, deciduous shrublands would receive most of the fire treatments, but spruce and aspen stands could also be treated.

Stand replacing fires in the black spruce forest could cause a shift from canopy dwelling to ground- and shrub-dwelling bird species. In some cases, over 70% of birds found in a burned area were not present in the preburn area. Numbers of black-backed woodpeckers could increase in the post-burn community, while ovenbirds may avoid burned areas. Fire can also cause a substantial reduction in the number of nesting territories the first few years after fire (Apfelbaum and Haney 1981).

Stand replacing fires in the boreal forest may skip as much as 15% to 20% of the area within their perimeters, providing a variety of habitats for wildlife and allowing resident species to find habitat even after the burn (Smith 2000). Stand-replacing fires can reduce the lichens that caribou use as forage in winter. For winter use, caribou prefer open forests in which preferred lichen species have reestablished, which usually takes at least 50 years after a fire. Their preference is related to abundance of food, snow cover, visibility from predators, and nearness to traditional travel routes. Lichens decline in old stands (over 200 years); thus fires of moderate to high severity may be needed to maintain forage for caribou in the long term (Klein 1982; Auclair 1983; Schaefer and Pruitt 1991; Thomas et al. 1995).

Temperate Desert Ecoregion. Nearly 60% of fire treatments would occur in the Temperate Desert Ecoregion, where the main vegetation types that would be treated are evergreen shrubland (e.g., sagebrush) and evergreen woodland (e.g., pinyon-juniper).

<u>Evergreen Shrubland</u>. Fire kills big sagebrush, little sagebrush, and black sagebrush. Fire can stimulate bitterbrush in a mountain big sagebrush community, but damage bitterbrush in a basin big sagebrush community (Bunting et al. 1985). Autumn burns are most harmful to sagebrush, while summer burns are most damaging to bitterbrush (Britton and Clark 1985, Vallentine 1989).

Several species of birds, including greater sage-grouse, sage thrasher, sage sparrow, and Brewer's sparrow are sagebrush obligates. Although the number of bird species in sagebrush habitats is far less than in forest habitats, some species, such as the greater sage-grouse, live nowhere else (Paige and Ritter 1999). Site selection by these species is positively correlated with sagebrush cover; greater sage-grouse require mature sagebrush as part of their habitat (Benson et al. 1991). Thus, burning must be done with caution to ensure that sufficient and suitable habitat remains for these species.

Fewer birds were observed after a fire in big sagebrush in Montana killed nearly 100% of the sagebrush (Bock and Bock 1978b). Sagebrush obligates avoided burned areas and used areas with sagebrush, although western meadowlark, a grassland bird, was attracted to the burn site (Huff and Smith 2000). Male attendance at sage-grouse leks in prescribed burn areas in Idaho were greater than untreated areas (Connelly et al. 2000a) Burning can create a long-term negative effect on greater sage-grouse nesting habitat because it can take sagebrush 20 or more years of postburn growth to develop sufficient canopy cover needed for greater sage-grouse nesting. Thus, prescribed fire should be used sparingly, or not at all, in sagebrush habitats. Prescribed fire can also harm shrews and other small mammals if patches of unburned vegetation are not provided in the burn area (Klebenow and Beall 1977, USDI BLM 1991a).

Fire can be used to create a mosaic of sagebrush and grassy patches, as long as key habitats are protected (e.g., greater sage-grouse nesting and brooding habitat). Increased grass production benefits mule deer and bighorn sheep (Lauer and Peek 1976; Willms et al. 1981; Payne and Bryant 1998). Neither extensive dense sagebrush nor extensive open space constitute optimal habitat for greater sage-grouse. While burning may restore the balance of plant community components in greater sage-grouse habitat, it also raises the risk of increasing downy brome productivity, which may cause the area to reburn before the sagebrush can recover. In a literature review, Connelly et al. (2000b) noted that prescribed burning has led to declines in greater sage-grouse breeding populations and has had long-term

negative impacts on nesting and brood-rearing habitats. They also cited studies that showed that forb populations held steady, while insect populations declined, when an area was burned, as compared to nonburned areas. Baker (2006) noted that a mosaic of burned and unburned areas may be tolerated by certain wildlife, but can be detrimental to sagebrush obligates.

Burning large areas to eradicate sagebrush is detrimental to birds in sagebrush habitats because it removes shrub cover (Paige and Ritter 1999). More importantly, it can promote the conversion of shrubland to non-native annuals such as downy brome. Wildfire suppression should be encouraged in areas prone to downy brome infestations. Restoring native plants is crucial before fire is reintroduced or allowed to continue if further conversion to downy brome is to be avoided.

Evergreen Woodland. Under natural fire cycles, the successional stages following fire are typically annuals; mixed annuals and perennials; perennial forb; grass and shrub; shrub and pinyon-juniper; and climax pinyon-juniper. Young pinyon and juniper trees are readily killed by fires, but older trees may be less susceptible due to thicker bark and more open crowns.

Treatments would focus on reducing the encroachment of pinyon-juniper woodlands into sagebrush-grass and grassland habitats. However, there is limited information on the effects of these treatments on wildlife species, even though over 70 species of birds nest in pinyon-juniper woodlands, and mule deer and elk are also important inhabitants. Birds, including pinyon jays, and other wildlife often initiate the reestablishment of woodland by transporting pinyon and juniper seeds and berries to burned areas. Pinyon-juniper woodlands also provide habitat structure that would be lost if woodlands were converted to grasslands (Maser and Gashwiler 1978). Reduction of pinyon-juniper habitat would adversely affect species that favor pinyon-juniper habitat, but should benefit species that favor habitat, such as grasslands, that result from pinyon-juniper treatments. Creation of a mosaic of pinyon-juniper, and different ages of recovering sagebrush-grass, would provide the widest diversity of habitat for wildlife.

Large burns create more homogenous conditions that are less favored by wildlife, and remove thermal and hiding cover needed by deer and elk (USDI BLM 1991a). Large burns can also damage large, older trees that provide mast of juniper berries and pinyon nuts (Balda and Masters 1980). Often, fire may not have much effect unless combined with other treatments, including mechanical treatments such as chaining. Burns conducted during spring are often more successful in promoting grass development, while burns during drier periods can reduce herbaceous yields and increase erosion (Wink and Wright 1973).

Subtropical Desert Ecoregion. About 1% of fire treatments would occur in the Subtropical Desert Ecoregion, and fire treatments would predominately occur in evergreen shrubland and perennial grassland communities.

In many areas of the Mojave and Sonoran deserts, plant communities are too sparse during most years to adequately carry a prescribed burn. Therefore, this type of treatment would not be suitable for these areas. In areas that have increased fuel loading as a result of invasive annuals like red brome, prescribed fire would negatively affect plant communities by encouraging the further spread of these invasive species. In the denser desert shrublands, where there is an adequate amount of fuel to support a fire, many shrubs, trees, and cacti could be severely affected by burning, as these species are not adapted to fire. Paloverde, burroweed, bursage, broom snakeweed, ocotillo, and creosote bush are examples of desert species that can suffer high mortality rates from burning (Wright and Bailey 1980).

Fire in desert grasslands may benefit scaled quail, but harm Gambel's quail (Wright and Bailey 1982). Fire suppression in some desert areas has allowed mule deer and white-tailed deer to expand their range and increase in numbers, thus prescribed fire could reduce habitat for these species.

Temperate Steppe Ecoregion. Seven percent of fire treatments would occur in the Temperate Steppe Ecoregion. Vegetation types that would likely receive fire treatments include evergreen forests, evergreen shrubland, and perennial graminoid communities.

Perennial Graminoid. Prescribed fire could have either positive or negative effects on plains grasslands of the Temperate Steppe Ecoregion, depending on its timing and severity. In some areas, use of infrequent, low intensity fires could benefit grasslands by preventing the encroachment of woody species. Some shrubs, however, would be difficult to control using fire. Honey mesquite and sand shinnery oak, for example, both have the ability to resprout vigorously after fire (Wright and Bailey 1980). In addition, fires may not reach high enough to kill taller shrubs that are encroaching into shortgrass habitats. Fire can kill seedlings of these shrubs, and topkill taller plants. Resizing them can

reduce their dominance on the site and improve water availability for grasses, forbs, and smaller shrubs.

Some butterfly species require forbs found in fire-dependent grasslands. The larvae, however, are usually very sensitive to fire. To protect butterflies, managers will often divide the landscape so every burn area contains patches that are not burned so that the butterfly can repopulate after the burn (Kwilosz and Knutson 1999).

In mountain grassland communities, where fire has been actively suppressed, prescribed fires could be beneficial to wildlife that favor grasslands by preventing the encroachment of woody species such as ponderosa pine, Douglas-fir, lodgepole pine, and sagebrush. However, bird species abundance is often higher in areas with shrubs.

Evergreen Forests. Open forest types (e.g., ponderosa pine, Douglas-fir, and western larch) would likely benefit from low-intensity prescribed fires, which would reduce the density of understory shrubs and tree seedlings, and encourage vigorous and abundant herbaceous vegetation and resprouting shrubs. Thinning, and sometimes removal of thinning slash, can be required in some of the dense stands before fire can be reintroduced. If thinning slash is not removed, the stand can still be susceptible to mortality from surface fires, even though the likelihood of crown fires has been significantly reduced.

Stand replacing fires typically result in many or most of the bird species present before the fire being replaced by new species (Finch et al. 1997). In the Grand Teton-Yellowstone region, more bird species were unique to the postburn community than to later stages of succession (100+ years; Taylor and Barmore 1980). In ponderosa pine forests in Arizona, stand-replacing fire also resulted in many bird species that were unique to the postburn community, while birds present before the burn left for other habitats (Lowe et al. 1978).

In ponderosa pine forests, granivores, tree drilling species, and some aerial insectivores usually increase after fires, while tree- and foliage-gleaning species usually decrease. Birds closely tied to foliage availability, such as hermit thrush, begin recovering as foliage volumes increase in subsequent years. Woodpecker abundance may peak in the first decade after fire, but then gradually decline (Finch et al. 1997).

A study of thinning and wildfire on small mammal populations in ponderosa pine forests found that several species, and total small mammal biomass, increased following thinnings and wildfire. The authors hypothesized that fuel reduction treatments would have the largest positive impact on small mammal populations in areas where tree densities are especially high (Converse et al. 2006).

Subtropical Steppe Ecoregion. Approximately 9% of fire treatments would occur in this ecoregion. Vegetation types that are proposed for vegetation treatments include perennial graminoid communities, evergreen shrublands, and evergreen woodlands. Treatments would focus on reducing hazardous fuels.

Perennial Graminoid. The xerophytic grasslands of the Subtropical Steppe Ecoregion support sparse shrubs and low trees, and exist on a continuum with evergreen woodlands (described below). The common plant species of grasslands would show a variety of responses to fire.

Prescribed fire treatments in the arid perennial grasslands of this ecoregion would potentially benefit these communities, and the wildlife they support, by controlling the invasion of shrubs such as mesquite, creosote bush, and tarbush. As is true for all of the plant communities discussed in this section, the benefits of fire would be dependent on the frequency of fire and the condition of the site prior to the burn, as well as the timing of the burn. Fires would maintain perennial bunchgrass communities at 5 to 40 year intervals. Fires would displace wildlife that depend upon shrub communities.

The effects of prescribed burns in winter on the relative abundance and species richness of breeding and wintering birds in mesquite grassland showed that relative abundance was greater in burned areas, but species richness was not different. Thus, unburned areas should be maintained next to burned areas to provide habitat for bird species that favor both habitat types (Reynolds and Krausman 1998).

Evergreen Shrubland. Chaparral shrub species in the Subtropical Steppe Ecoregion are fire-dependent, are comprised of highly flammable species, and grow rapidly after fire, taking about 25 years to mature and senesce (Brown and Smith 2000). The production of dead fuels in chaparral stands is not well understood, but it probably increases with age and after a drought. Fuels in chaparral communities are not as easily ignited as grass fuels, but will burn readily under hot, dry conditions.

In Arizona, fire is the main management tool used to open dense shrub canopies for edge wildlife. Although chaparral sprout vigorously within a few years after a burn, repeated burns can harm plants. Fire plus herbicides eliminates birchleaf mountain mahogany, a preferred deer food (Severson and Medina 1983). Burns during the warmer and drier periods of the year can also be harmful to vegetation used by wildlife.

Fire and herbicide treatments have been used to control chaparral in Oklahoma. Herbicide applications without fire do not benefit most reptiles, while herbicide applications with fire can adversely affect amphibians. Where eastern red cedar has invaded grassland habitats and now dominates, reptile and amphibian populations are reduced from historic levels. Maintenance of a mosaic of habitats is needed to maintain a diversity of reptiles and amphibians in chaparral.

Mediterranean Ecoregion. Fire treatments in the Mediterranean Ecoregion would be directed at evergreen forest and evergreen woodland. About 4% of fire use would occur in this ecoregion, and treatments would support efforts to improve forest health and reduce hazardous fuels. Evergreen forests in this region historically had an understory fire regime or a mixed severity fire regime, and are presently at risk for high-intensity, stand-replacing crown fires due to large fuel accumulations.

Changes in avian communities were studied in evergreen forests in the Sierra Nevada range. Changes in the avian community were related to changes in vegetation structure with succession. In the first 8 years after the burn, bird abundance on burned plots was similar to that on unburned plots, but species that were characteristic of low shrub and ground habitats predominated in burned areas. Woodpeckers were also more common on the burn area after the burn than before. By year 15 after the burn, bird diversity had decreased, as fewer snags were present and the shrub cover became denser. As the shrub community continued to develop from years 15 to 25, birds that fed and nested in shrubs also increased (Bock et al. 1978).

Frequent, low intensity fires help to maintain open oak stands with a grassy understory in the Mediterranean and the Marine ecoregions (Agee 1993). More intense fires can kill oaks. Some oaks do not produce mast until they are a certain size, and if fire kills trees before they become large enough, mast production for birds and squirrels can be limited (McCulloch et al. 1965).

Marine Ecoregion. Approximately 2% of fire treatments would occur in the Marine Ecoregion, primarily in evergreen woodlands and forests.

These humid maritime forests are extensive at lower and middle elevations west of the Cascades and the British Columbia Coast Range. The cooler, wetter, and more northerly portions of the coastal Douglas-fir type (generally associated with the mountains of western Washington and southwestern British Columbia) burned in stand-replacement fires at long intervals, averaging 200 to several hundred years (Agee 1993).

In Washington, stand-replacing fires in western hemlock forests resulted in the bird community shifting from one dominated by canopy-dwelling species to one dominated by species that nested and foraged near the ground (Huff et al. 1985). Once a full canopy develops in a hemlock forest, few changes occur in bird species composition. Since fire return intervals are long in hemlock forests, bird species composition may remain relatively stable for centuries. Long fire return intervals and large forest stands would benefit forest-interior dwelling species, while forest-edge species and species that favor early successional plant communities would be found in recently-burned areas.

Effects of Mechanical and Manual Treatments

Approximately 80% of mechanical treatments would occur in the Temperate Desert Ecoregion, and 7% and 5% would occur in the Temperate Steppe and Mediterranean ecoregions, respectively. Forty percent of treatments would occur in evergreen shrubland and 20% in evergreen woodland communities.

Mechanical treatments would injure or kill plants by removing some or all of the plant material on the treatment site. Mechanical methods are effective in restoring wildlife habitat and are the primary means of reseeding a site. However, equipment is often noisy, and noise may alter animal behavior or cause wildlife to leave an area during the disturbance period.

Manual treatments can be expensive, but they allow for more precise vegetation control than other methods and are often suitable in areas with sensitive wildlife species. Hand-held equipment, including chainsaws, create noise that can disturb animals and cause them to flee or alter their behavior or habitat use. These effects would be short-term and not likely to have much effect on the long-term health and habitat use of wildlife in the treatment area.

Mechanical Effects by Ecoregion

Tundra Ecoregion. No mechanical treatments are scheduled to occur in this ecoregion. If treatments were to occur, they would be designed to minimize damage to tundra by scheduling them during the appropriate season and/or using the appropriate equipment.

Subarctic Ecoregion. No mechanical treatments are scheduled to occur in this ecoregion. If treatments were to occur, they would occur predominantly in mixed evergreen/deciduous forests and evergreen forests. Treatments could be used to create a mosaic of habitats for wildlife. Mechanical treatments would be favored in areas where habitat management was required, but where use of fire or chemicals would provide less control or could result in harm to human life or property or to species of concern and their habitats.

Temperate Desert Ecoregion. An overwhelming majority of the proposed mechanical treatments would occur in the Temperate Desert Ecoregion, in evergreen shrubland communities.

<u>Evergreen Shrubland</u>. Most of the mechanical treatments in evergreen shrubland would involve tilling or plowing of sagebrush, followed by seeding or drilling. Other mechanical treatments, such as mowing, chopping, and chaining, would also be used, but to a lesser extent. Treatments would target woody species (e.g., big sagebrush, rabbitbrush, and greasewood), with the goal of encouraging certain species of perennial bunchgrasses, forbs, and shrubs. Plowing would be used in areas with little herbaceous understory, where soil disturbance would help prepare the seedbed for revegetation.

Mechanical treatments can be used to create openings in sagebrush habitats for use as foraging habitat and greater sage-grouse leks. Mechanical treatments also eliminate the uncertainty of size and shape of treatment that is common with prescribed burning (Urness 1979). Mechanical treatments can be designed to avoid more important sagebrush species or patches of habitat.

Mechanical methods to treat sagebrush include plowing, disking, rotobeating, chaining, and shredding. Chaining is often favored because it does not kill all of the sagebrush and retains native grasses and forbs important to wildlife and their young. Chaining can further benefit wildlife if chaining is done in strips, rather than blocks, and by using natural terrain features to maximize edge effect (Autenrieth et al. 1982).

Mechanical treatments should leave at least 70% of sagebrush habitat intact and treatments should be made in alternating strips of treated and untreated vegetation. Disturbed strips should be no wider than 350 feet to maintain bird species diversity and satisfies greater sage-grouse needs (Castrale 1982).

<u>Evergreen Woodlands</u>. Mechanical treatments in pinyon-juniper woodlands would primarily consist of thinning and machine piling of debris, as well as chipping/shredding and chaining to reduce the occurrence of pinyon and juniper species on sites in which they have invaded. As a result of tree removal, many native perennial grass species, forbs, and shrubs would increase on the site (Clary 1971, Jacobs and Gatewood 1999).

Various mechanical methods, including chaining, cabling, and bulldozing, are used to treat pinyon-juniper woodlands. Extensive modifications over large areas should be avoided, however, as these woodlands provide habitat for numerous birds, small mammals, and other wildlife.

Treatments that remove large amounts of pinyon-juniper woodlands can adversely affect interior species of wildlife and species that feed upon insects found on the plant surface and under the bark. If possible, large 1,000-acre or larger blocks of pinyon-juniper should be retained. Effort should also be made to retain trees for cavity-nesting birds and as perches (Payne and Bryant 1998).

Mule deer use pinyon-juniper woodlands, and about 54% of mule deer winter habitat in Utah is pinyon-juniper. Removal of pinyon-juniper would reduce the amount of food and cover for these animals (Terrell and Spillet 1975). In Oregon, pinyon-juniper woodlands support a greater diversity of bird species than many forest communities. Reptiles, rodents, rabbits, and other small and large mammals depend upon these communities (Maser and Gashwiler 1978).

Subtropical Desert Ecoregion. In the Subtropical Desert Ecoregion, some mechanical treatments are likely to occur in evergreen and deciduous shrublands. Mechanical treatments could benefit native communities by controlling woody shrub species, which have invaded desert grasslands and now occur in much greater densities than they have historically.

Land managers should be careful when modifying shrub habitats. They are used by a variety of small mammals and birds, and some species, such as Gambel's quail,

prefer dense stands of desert shrub where shrub cover is more than 50% and shrubs are over 6 feet tall (Cooperrider et al. 1986). Shrub removal should be avoided in riparian areas and in draws, where shrubs provide important cover and forage for wildlife in an ecoregion where food and cover can be limiting (Short 1983). Short (1983) observed that several bird guilds used the creosote bush-bursage, Joshua tree-creosote bush, and saguaro-paloverde communities and that removing these plant communities would have adverse effects on many species of birds. In addition, management should strive to protect mature cactus, since they provide foraging sites, nest cavities, and perches for birds.

Temperate Steppe Ecoregion. In the Temperate Steppe Ecoregion, mechanical treatments would likely occur in evergreen forest, evergreen shrubland, and evergreen woodland communities. Mechanical treatments in forest communities would largely consist of thinning treatments to reduce the density of trees and the accumulation of understory fuels. Treatments would primarily be focused on reducing hazardous fuels in the WUI; improvement of wildlife habitat would be a secondary benefit.

Treatments would be used to reduce the extent of woodland communities, especially in areas where they are encroaching into grassland communities. Treatments include using chaining, blading, or similar methods to create openings, and then using fire to maintain openings (Payne and Bryant 1998). Livestock grazing can also be used to maintain openings. These openings interspersed with woodlands stands provide a good mosaic of habitat for wildlife. However, these treatments adversely affect interior species that depend on large, continuous stands of woodland.

Chaining, rootplowing, and disking have been used to control mesquite and juniper that invade prairies. Rootplowing kills plants, but also disturbs soil. Removal of woodland stands in bottomland sites and along drainages may reduce the amount of forage and cover for deer. Turkeys also avoid cleared areas. Treatments that open small patches or strips of woodland should provide the greatest benefits to species that use these habitats.

Subtropical Steppe Ecoregion. In the Subtropical Steppe Ecoregion, mechanical treatments would likely occur in evergreen woodland and evergreen forest communities.

The general effects of mechanical treatments on pinyon-juniper woodlands in this ecoregion would be largely the same as the effects on pinyon-juniper in the Temperate Desert Ecoregion. The warmer and wetter conditions in the Subtropical Steppe Ecoregion would likely result in more favorable vegetation response following treatment compared to similar vegetation types in the Temperate Desert Ecoregion.

Dense stands of chaparral could be treated mechanically to create openings. Rootplowing tends to be unfavorable for deer because it removes too much cover, and treatments that eliminate much of the midstory can negatively affect birds that forage and nest in these habitats (Urness 1974, Short 1983).

Mediterranean Ecoregion. In the Mediterranean Ecoregion, mechanical treatments would likely occur in evergreen woodland, evergreen forest, and evergreen shrubland communities.

Modification of oak woodlands can harm bird species if it reduces the number of niches or alters forage and cover habitat. Mechanical treatments in oak woodlands would benefit wildlife by removing conifers and other encroaching woody species that have increased the density of these communities, and by stimulating the growth of understory forbs and grasses.

The BLM could conduct treatments on juniper woodlands in northern California to reduce the spread of this species. Removal of junipers would reduce habitat for species that use the berries and structure of junipers for food and cover. However, removal would improve habitat for species that prefer herbaceous and shrub vegetation that would dominate the site after junipers were removed.

Marine Ecoregion. In the Marine Ecoregion, mechanical treatments would likely occur in evergreen woodland and evergreen forest communities.

The general effects of mechanical treatments on oak woodlands habitats would be similar to treatments in oak woodlands in the Mediterranean Ecoregion.

Thinnings and other woody biomass removal would be used in evergreen forests to maintain forests and improve forest health, and to reduce the amount of hazardous fuels present. Where thinnings promote development of the understory, wildlife species that favor more open understories would be harmed. If treatments were conducted to reduce understory vegetation to reduce the risk of fire, ground- and shrub-

nesting birds would be harmed and less browse would be available for deer, elk, and other herbivores. If treatments were used to promote mid-seral stages characteristic of most timber management, little habitat would be provided for old-growth species, such as northern spotted owl and black-tailed deer. In particular, removal of decayed and malformed trees would tend to reduce the number of tree cavities for owls, while fewer large trees would be available to intercept snow to improve conditions for deer during winter (Hunter 1990).

Effects of Biological Treatments

Nearly 90% of biological control treatments would occur in the Temperate Steppe (48%) and Mediterranean (40%) ecoregions. Over half of treatments would control annual grasses or forbs (e.g. diffuse knapweed, medusahead, yellow starthistle) and perennial forbs (e.g., some knapweeds, some thistles, leafy spurge, purple loosestrife, dalmatian toadflax).

Containment by Domestic Animals

Domestic livestock can be used to reduce or contain undesirable vegetation in some situations. These treatments would generally occur in herbaceous communities (annual and perennial grassland and perennial forb communities) that have significant weed infestations.

Herbivores, whether wild or domestic, influence vegetation development. Improper grazing can 1) remove residual cover needed for ground-nesting birds; 2) create undesirable shifts in successions that can cause significant and difficult-to-reverse impacts to wildlife habitat; 3) reduce wildlife food and cover; and 5) reduce plant species diversity. Livestock can directly harm wildlife by trampling on animals or their nests, and grazing can alter grassland structure, to the detriment of birds and small mammals (Wiens and Dyer 1975).

In some cases, using prescribed grazing by domestic animals is not an effective tool for managing vegetation. When grazing is used for management, care should be taken to ensure that livestock do not substantially alter habitat structure. Certain habitats may be more sensitive to impacts caused by the use of livestock to control vegetation and therefore would require extra planning and management to be successful. The use of livestock in wetland and riparian areas not only has the potential to directly impact non-targeted vegetation, but there could also be unintended impacts to soils, streambanks, and stream morphology. Hot desert environments are fragile and recover slowly even after grazing exclusion. Tundra and subarctic environments are additional examples of habitat where livestock grazing is probably impractical and less likely to achieve desired results.

Significant biological control treatments are proposed for the annual graminoid/forb communities of the Mediterranean Ecoregion. Of note is a single large proposed grazing project. Because annual grasslands in California evolved in conjunction with heavy grazing regimes, grazing treatments would be unlikely to cause major changes to the vegetation communities that currently exist (Sims 1988). In addition, domestic animals would benefit these open communities by helping to prevent the encroachment of woody species.

Biological Control Agents

The effects of biological treatment using insects and pathogens would be minor. In most cases, the target plants would remain standing, although weakened or unable to reproduce. Insects are often used to control weeds because many species exhibit high host-specificity (Wilson and McCaffrey 1999). However, the success of biological control programs often depends on the presence of a more desirable plant community that can fill in the spaces opened by the removal of the weed. Thus, biological control would not be effective where large stands of annual grasses, such as downy brome, are present and have displaced native vegetation. If the weed is controlled, the space is often filled by another weed, or the plant community reverts to the weed annual grass understory. Because control using biological agents would take time, wildlife might be better able to respond to changes in habitat than after treatments that modify habitat over a short period of time, such as fire and herbicide use.

Effects of Chemical Treatments

Approximately 16% of treatments would involve the use of herbicides; a similar percentage of acres are currently treated using herbicides. Over 70% of acres would be treated in the Temperate Desert Ecoregion, a much greater proportion than is currently treated in this ecoregion. Fifteen percent of treatments would occur in the Temperate Steppe Ecoregion. Treatments in the Temperate Desert Ecoregion would be targeted primarily toward sagebrush, rabbitbrush, and other evergreen shrubland species, and annual grass and perennial forb weeds, while those in the Temperate Steppe Ecoregion would focus on control of invasive annual and perennial grasses and forbs.

While some field studies suggest that appropriate herbicide use is not likely to directly affect wildlife (Cole et al. 1997; Sullivan et al. 1998), herbicides (used properly or improperly) can potentially harm wildlife individuals, populations, or species (USDA Forest Service 2005). Harm at the population or species level is unlikely for non-special status species because of the size and distribution of treatment areas relative to the dispersal of wildlife populations and the foraging area and behavior of individual animals.

Possible adverse direct effects to individual animals include death, damage to vital organs, change in body weight, decrease in healthy offspring, and increased susceptibility to predation. Adverse indirect effects include reduction in plant species diversity and consequent availability of preferred food, habitat, and breeding areas; decrease in wildlife population densities within the first year following application as a result of limited regeneration; habitat and range disruption (as wildlife may avoid sprayed areas for several years following treatment), resulting in changes to territorial boundaries and breeding and nesting behaviors; and increase in predation of small mammals due to loss of ground cover (USEPA 1998b).

In the absence of prominent direct effects, the main risk to wildlife from herbicide use is habitat modification. In forests, for example, herbicide use may result in minor and temporary effects on plant communities and wildlife habitats, including some beneficial effects, but usually result in a significant drop in forage the season following treatment. However, forage species and wildlife use of treated areas are likely to recover within 2 to several years after treatment (Escholz et al. 1996; McNabb 1997; Miller and Miller 2004).

The extent of direct and indirect effects to wildlife would vary by the effectiveness of herbicide treatments in controlling target plants and promoting the growth of native vegetation, as well as by the extent and method of treatment (e.g., aerial vs. ground) and chemical used (e.g., toxic vs. non-toxic; selective vs. non-selective), the physical features of the terrain (e.g., soil type, slope), and weather conditions (e.g., wind speed) at the time of application. The effects of herbicide use on wildlife would depend directly on the sensitivity of each species to the particular herbicides used (and the pathway by which the individual animal was exposed to the herbicide), and indirectly on the degree to which a species or individual was positively or negatively affected by changes in habitat. Species that reside in an area year round and have a small home range (e.g., amphibians, small mammals), would have a greater chance of being directly adversely affected if their home range was partially or completely sprayed because they would have greater exposure to herbicides—either via direct contact upon application or indirect contact as a result of touching or ingesting treated vegetation.

In addition, species feeding on animals that have been exposed to high levels of herbicide would be more likely to be affected, particularly if the herbicide bioaccumulated in their systems. Although these scenarios were not modeled for the PEIS, wildlife could also experience greater effects in systems where herbicide transport is more likely, such as areas where herbicides are aerially sprayed, dry areas with high winds, or areas where rainfall is high and soils are porous. Wildlife that inhabit subsurface areas (e.g., insects, burrowing mammals) may also be at higher risk if soils are non-porous and herbicides have high soil-residence times. The degree of vegetation interception, which depends on site and application characteristics, would also affect direct spray effects. The effects of herbicide use on wildlife would be site- and application-specific, and as such, site assessments would have to be performed, using available information to determine an herbicide-use strategy that would minimize impacts to wildlife, particularly in habitat that supports special status species.

The BLM and Forest Service risk assessments suggested several common effects of herbicides to wildlife. Birds or mammals that eat grass that has been sprayed with herbicides have relatively greater risk for harm than animals that eat other vegetation or seeds, because herbicide residue is higher on grass (Fletcher et al. 1994; Pfleeger et al. 1996); this phenomenon is apparent in risks predicted for large mammalian herbivores by the BLM risk assessments. Grass foragers might include deer, elk, rabbit and hare, chukar, quail, and geese (USDA Forest Service 2005). However, harmful doses of herbicide are not likely unless the animal forages exclusively within the treatment area for an entire day. For example, studies of white-tailed deer have reported an average home range of about 400 acres (Fowler 2005), which would be about the size of the typical application area (two-thirds of herbicide treatments would be 400 acres or less), and less than half the size of a large application area of 1,000 acres (20% of treatments would be 1,000 acres or larger). Scenarios of chronic consumption of contaminated vegetation would also be unlikely if vegetation were to show signs of damage (these signs may not occur immediately after spraying). In addition, insect foragers (e.g., bats, shrews, and numerous bird species) would be

at risk from herbicide applications because of the small size of insects and their correspondingly large surface area.

The PEIS includes additional information on the risks of using herbicides for wildlife habitat improvement. The reader is encouraged to review the PEIS and its Appendix C for more information.

Beneficial Effects of Treatments

Treatments that remove hazardous fuels from public lands, reduce the spread of weeds and other invasive vegetation, and restore native vegetation in areas that have been degraded by human-related activities would benefit wildlife habitat. Treatments would help to restore natural succession and disturbance processes to which native wildlife have adapted. In addition, treatments would increase plant diversity across landscapes, and in turn increase the number and types of wildlife that can be supported.

Traditional forestry and fire management has resulted in the loss of large shade-intolerant trees and favored the development of dense mid-seral forests. These practices have also reduced the number of dead and dying trees that can be used by cavity nesting species, and by other species, such as amphibians and burrowing small mammals, that used dead and rotting wood for shelter and food. Overall, there has been a loss of habitat diversity and complexity in managed forests; the number and types of animals that can be supported by these forests has also declined (Hunter 1990, USDA Forest Service and USDI BLM 2000b). Forests are more susceptible to catastrophic wildfire, with its inherent negative effects to wildlife survivorship and habitat. Forest management that restores natural succession and disturbance regimes would improve the health of forests on public lands and ability of forests to support a diversity and abundance of wildlife.

Weeds and other invasive species provide forage and cover for wildlife, such as chukar, and treatments to reduce the spread of weeds and other invasive vegetation would be harmful to these wildlife. However, if invasive species management increased plant species diversity and fostered healthy ecosystems that were more resilient to fire and invasive species encroachment, greater numbers and types of wildlife should be supported by the area, and risks to special status species and other species found in low numbers in treated ecosystems should be reduced.

Wildland fire, spread of weeds, and other factors have caused habitat fragmentation and the loss of connectivity between blocks of habitat, especially in lower elevation forests, shrub steppe, and riparian areas. Fragmentation has isolated some animal populations and reduced the ability of populations to disperse across the landscape. Treatments that restore native vegetation in disturbed areas should reduce fragmentation and restore connectivity among blocks of similar habitat.

Effects of Fire Treatments

Habitat structure follows successional trends in most communities. Short fire intervals tend to maintain or promote early successional plant communities characterized by herbaceous species and limited structural diversity (Anderson 2001). Long fire intervals and a typical successional pathway normally results in more woody species and greater structural diversity. Fires that set back succession tend to benefit herbivores and species that depend on herbaceous vegetation for cover. Red fox, gray fox, and weasel prey upon herbivores and are also associated with early to mid-successional habitats (Allen 1987). Older forests provide suitable prey, nest cavities, and more open flight corridors for owls than younger, denser forests. In the Pacific Northwest in areas of high snowfall, deer seek out more mature forests in winter for their snow-intercept thermal cover. In these forests, large branches capture much of the snowfall, keeping snowfall amounts at ground level much less than in younger forests, making it easier for deer to travel in snow and find shrubs and other forage.

Replacement of fire-adapted vegetation by fire-intolerant associations generally leads to overall declines in herpetofauna abundance and diversity. Prescribed fire is an appropriate management tool that can be used with other tools to benefit herpetofauna by restoring a historical mosaic of successional stages, habitat structures, and plant species composition. However, prescribed fire may not be appropriate for herpetofauna species that depend upon late-successional or climax vegetation (see review in Russell et al. 1999).

Fire generally leads to increases in plant nutrient density, palatability, and earlier "greenup." However, this phenomenon normally only lasts for a few growing seasons. Hobbs and Spowart (1984) observed that winter diet quality for deer and bighorn sheep improved as a result of burning. Although the quality of individual forage items did not change substantially, forage items were more readily available. Beneficial treatments

include those that target encroaching conifers that are reducing the acreage of bighorn winter range.

Tundra and Subarctic Ecoregions

Burning is not generally recommended on tundra. However, burning to remove lichens that smother more desirable plants has been used to improve habitat for willow ptarmigan (Payne and Bryant 1998).

Mixed-severity fires stimulate growth of most herbaceous and shrub cover. Stand replacing fires improve woody browse for moose. Aspen and spruce stands that are replaced by stand-replacing fires produce more browse in the first few years after burns than older stands. The benefits of these fires to moose may peak at about 25 years after a fire and last less than 50 years (Oldemeyer et al 1977; Wolff 1978; MacCracken and Viereck 1990).

Temperate Desert Ecoregion

Prescribed fire could reduce sagebrush cover and promote grass species that would be attractive to horned larks and meadowlarks. As burned areas recovered, sage and Brewer's sparrows would become more common (Rotenberry and Wiens 1978). It could take 4 or more years before bird populations reached pre-burn levels (Smith 2000). Pronghorn also benefit from a combination of grassland and shrubland, perhaps because dense stands of sagebrush can hinder pronghorn movement (Anderson 2001).

In shrublands where invasion by downy brome is not a factor, a mosaic-patterned fire is recommended in sagebrush as long as 50% to 60% of the sagebrush survives. Openings created in dense sagebrush stands were used as new leks for greater sage-grouse in Idaho (Connelly et al. 1981).

Forb and insect availability are important factors in sage-grouse productivity, and fire increases openings in sagebrush, increasing forb production. Fire may also increase the nutritional value of the browse and provide new lekking sites (Martin 1990; Benson et al. 1991; Pyle and Crawford 1996). However, intact stands of sagebrush are required as wintering habitat and to provide cover during all seasons. Prescribed burns should be conducted every 15 to 20 years or more (Payne and Bryant 1998). Extensive areas of higher elevation big sagebrush stands have been invaded, and in some places replaced, by pinyon and/or juniper. Treating these areas and allowing the reestablishment of grasses, forbs, and eventually big sage, can be beneficial to greater sage-grouse, especially as summer habitat.

A mosaic of pinyon-juniper woodland, grassland, and intermediate seral communities would optimize wildlife diversity (Belsky 1996). When conditions are favorable for stand-replacing fire, burning kills most of the pinyon-juniper overstory and increases plant diversity. However, some large, older trees should be maintained for mast and berry production for birds and other wildlife (Balda and Masters 1980). While loss of pinyon-juniper can reduce thermal and hiding cover for ungulates, an increase in plant species diversity after fire, particularly of forbs and grasses, can benefit deer and elk, as well as ground-nesting birds.

Burning can be used to create openings and early successional stages and to promote forage production (Payne and Bryant 1998). Small burns are favored because they create a greater variety of food and cover conditions than do larger burned or unburned areas (Short and McCulloch 1977).

Subtropical Desert Ecoregion

Fuel accumulations in the Mojave, Sonoran, and Chihuahuan deserts are generally too sparse to carry a fire, except after wet winters and springs. Fires can affect grass and shrub cover and productivity, and thus must be used carefully, if at all, to modify wildlife habitat. Fire can be beneficial if it stimulates grass and forb production (Bock and Bock 1990, Payne and Bryant 1998). If burning creates a mosaic of habitats, with extensive unfragmented habitats, wildlife would benefit.

Fire has been used to control mesquite to the benefit of wildlife. Fire can also be used with mechanical and chemical methods to maintain openings to the benefit of mourning doves and other species than need a mix of openings and shrub cover (Payne and Bryant 1998). Mosaic sites with varying densities of mesquite support high reptilian diversity, while sites with scattered mesquite benefit doves and quail (Germano and Hungerford 1981, Bock and Bock 1990).

Fire has been used to increase forb production in mixed prairie and oak communities. Deer forage and density are often greater in burned than unburned areas, and burns can also benefit quail and other birds (Jackson 1965; Hutchenson et al. 1989). In some cases, oak habitats become so dense that deer and other animals cannot penetrate them, or trees grow beyond the reach of ungulates.

Temperate Steppe Ecoregion

Patchy or irregular burns can enhance habitat diversity in grasslands that have little structural diversity. Heterogeneous mosaics of grasses and forbs are a more suitable habitat for some nongame birds than uniform stands of either (Verner 1975). Burning at 3- to 5-year intervals restores vigor and retards succession to optimize foraging habitat for prairie chickens (Kirsch 1974), although the quality of nesting habitat and availability of thermal and escape cover for prairie chickens may be reduced for several years following a burn (Boyd and Bidwell 2001).

Periodic burning also enhances small mammal populations in grasslands, although burns should be kept small and effort should be made to create a mosaic of habitats (Kaufman et al. 1990). For species that require protective cover, fall or early winter burns would be best. Wild ungulates also seek out burned areas. When conducting burns in grasslands, some shrub species should be protected to provide habitat for nesting and perching birds.

Fire should be limited to small, localized burns in prairie, as recovery of grass biomass can take several years. This type of management can benefit pronghorn and birds (Payne and Bryant 1998). Fire has been used to enhance waterfowl and shorebird nesting habitat (Kirsch and Kruse 1972). Fire can also help maintain prairie chicken habitat, but burned areas may not be used by sharp-tailed grouse for several years.

Understory fire regimes are needed to support northern goshawk populations in ponderosa pine forests. Management that increases the predominance of early-seral and mid-seral species, increases the number of large trees on the landscape, and maintains connectivity between patches benefits goshawks (Graham et al. 1999).

In Douglas-fir forests in Montana, small stand-replacing fires often leave many unburned patches. The burn areas attract wood-boring insects, woodpeckers, and warblers. The unburned areas attract Swainson's thrush. In ponderosa pine and Douglas-fir forest, patches of old-growth trees attract flammulated owls, but only if the patches of old growth are accompanied by grassy openings and some dense thickets of Douglas-fir. Stands embedded within a landscape of closed, mature forest do not support many owls. Thus, understory fire can be used to create openings and enhance habitat for the owls (Wright 1996).

In prairies, fires eliminate trees and increase the amount of forage available for grassland species. Grassland fires can cause early green-up of warm-season grasses, and increase grass forage production. Fire also increases the percentage of protein and minerals in prairie grasses and shrubs (Daubenmire 1969).

Burning produces positive results for deer and elk forage in evergreen forests by increasing grass and forb production after fires. These benefits generally last less than 30 years. However, if weeds and other invasive species predominate as a result of fire, the benefits to wildlife from fire in these forests would be few (Smith 2000). Mixed-severity and stand-replacement fires also stimulate berry-producing shrubs and their productivity for 20 to 60 years after fire, to the benefit of birds, small mammals, and bears.

Stand-replacement fires improve the protein content and other nutritional components of forage species in aspen, ponderosa pine, western larch, and Douglas-fir stands. Burning can also improve access to forage for elk and other wildlife. In one study, burns in mountain shrub and grassland habitats increased the level of protein and in vitro digestible organic matter in winter diets of bighorn sheep and mule deer, but had no detectable effects on spring diets (Hobbs and Spowart 1984).

Subtropical Steppe Ecoregion

Fire has been used in evergreen woodlands in Arizona. Fire stimulates shrub browse and creates openings where grasses and forbs can thrive. Birds are often more abundant in burned areas than unburned areas, but rodent populations sometimes decline in burn areas. In dense chaparral, fire is used to create openings and increase edge habitat for wildlife. Fire can also improve forage quality. Burning chaparral can shift rodent populations from chaparral to grassland-dominant areas (Wright and Bailey 1982).

Most shrubs in chaparral sprout vigorously from the crown and can recover within 5 to 10 years after fire. Small burns conducted on a 10- to 20-year rotation are beneficial to wildlife (Severson and Medina 1983, Bock and Bock 1988). Rotational burning can greatly improve deer browse in chaparral communities (Wright and Bailey 1982).

Fire may enhance grassland communities. Bock and Bock (1978a) found more raptors and game birds in burned grasslands than unburned grasslands. Lark sparrow and mourning dove nest densities are also

greater in burned than unburned grasslands (Sontiere and Bolen 1976, Renwald 1977).

Mediterranean Ecoregion

In coastal sage scrub, a stand replacing fire would initially reduce the number of birds that use the scrub. However, by the end of the first year, species richness should be 70% to 90% of preburn levels, with species favoring more open areas being most abundant (Moriarty et al. 1985).

Burning has been used to create habitat for black-tailed deer in chamise chaparral. Taber and Dasmann (1958) found a 300% to 400% increase in deer use after a wildfire, and deer reproduction improved. Mechanical methods can be used along with fire to create openings for deer in chaparral (Biswell 1969). However, at least 30% of the area should be maintained to provide cover. Large burns are not good for deer or birds in chaparral habitats, as there is too much habitat fragmentation (Buttery and Shields 1975). Thus, small openings and brush islands within larger burns can increase bird species diversity.

Forage of deerbrush and other chaparral species is abundant after fire because it reproduces from seed that is stimulated to germinate by burning. Chaparral plants provide forage for many ungulate species (Burcham 1974).

Marine Ecoregion

Fire has been used to increase plant diversity and structural complexity in evergreen forestlands. Huff et al. (1985) found the greatest bird diversity in forests about 20 years after a burn.

Salmonberry provides fruit for birds and bears and leafy vegetation and twigs for deer, elk, mountain goats, and moose. Salmonberry sprouts prolifically after fire, although severe fire could reduce sprouting (Tappeiner et al. 1988; Zasada et al. 1989).

Effects of Mechanical and Manual Treatments

Mechanical treatments are often preferred to fire and herbicide use because they allow for more precise control of the vegetation treated. Fire and large scale herbicide treatments have the potential to modify or eradicate large areas of vegetation, to the detriment of obligate species and species needing structural and floral diversity or hiding or thermal cover. Prudent, well-designed mechanical treatments can result in a mosaic of habitats in different stages of disturbance and successional recovery (Payne and Bryant 1998).

Manual and mechanical treatments are especially effective in sensitive areas, such as wetland and riparian habitat, or near habitats of plant and animal species of concern, where greater control over treatment effects is required or effects to non-target species are a concern.

Killing big sagebrush by mechanical methods can release rabbitbrush, a generally undesirable plant. Mechanical methods are favored to thin sagebrush stands, while leaving other shrubs, grasses, and forbs, to benefit big game winter range (Payne and Bryant 1998). Mechanical methods have been used to control the encroachment of pinyon and juniper into sagebrush sites. These woodland species can be removed or thinned, while still retaining some patches for wildlife.

Pronghorn, mule deer, and elk benefit from mechanical treatments by foraging on strips of grasses and forbs that are created. Similar treatments should be considered for greasewood and shadscale saltbush communities to provide suitable habitat for black-tailed jackrabbits, and kit fox that prey upon jackrabbits (Spowart and Samson 1986).

Opening dense stands of pinyon and juniper benefits edge species, ground-feeding and ground-nesting birds, and small mammals. Openings of 250 acres or less by mechanical means benefit deer, small mammals, and turkeys and other birds. Breeding bird densities differ in treated and untreated areas, with ground-nesting birds being more prevalent in chained versus unchained pinyon-juniper stands. Thus, treatments that create patches of treated and untreated pinyon and juniper should promote species diversity (Scott and Boeker 1977; O'Meara et al. 1981; Payne and Bryant 1998).

Leaving slash, debris, and downed trees provides microhabitat for rabbits and songbirds. For deer, slash and debris should cover 20% or less of the treated site (Terrell and Spillet 1975). Treatment costs can be reduced by using harvested material as biofuel.

Mechanical treatments in the Temperate Steppe Ecoregion would primarily occur in evergreen forests and woodlands. Thinning of trees using mechanical harvesting equipment would create openings and increase light penetration to the understory, improving forb and shrub production to the benefit of deer and other wildlife. Trees that are removed could be used in biofuel production to reduce treatment costs.

Disking and chaining to thin and remove woodland vegetation and create openings with forbs and grasses benefits birds and small mammals. When treating forestlands and woodlands, managers should create openings within the forest/woodland stand; leave slash and downed trees for rabbits and other ground-residing wildlife; maintain shrub canopies for vireos, thrushes, and other birds; create edge habitat while also maintaining large patches of woodland/forestland habitat for interior species; and use burning to maintain habitat (Payne and Bryant 1998).

Gambel and other oak woodlands are important to wildlife in the Subtropical Steppe Ecoregion. Over 40 species of birds and 20 species of mammals use Gambel oak communities (Harper et al. 1985). Mechanical treatments can benefit oak woodlands by increasing oak sprouts for ungulate forage, reducing oak dominance to promote the development of forbs and grasses as forage and cover, and protecting oak stands from ponderosa pine and other tree encroachment to ensure future mast production (Payne and Bryant 1998). Lack of disturbance can limit the distribution, vigor, and growth of Gambel oak (Vallentine 1989). Bulldozing generally results in more oak sprouting than hand cutting, and increases forage production for deer and other wildlife compared to untreated areas (Rutherford and Snyder 1983). However, mast producing trees should be protected by limiting bulldozing to trees less than 3 inches diameter at breast height to avoid loss of mast-producing trees. Chaining has been done in Utah to reduce Gambel oak and increase herbaceous forage (Plummer et al. 1968).

Where shinnery oak is too thick or has expanded distribution, shredding or mowing oak thickets while leaving about 10% of the area untreated would provide good habitat for quail while still protecting some mast trees (Payne and Bryant 1998). Groups of shinnery oak trees should be retained to provide habitat for quail, deer, and lesser prairie chicken.

Mechanical treatment has been used to increase grass production by creating openings in chaparral (Severson and Medina 1983). Treatments that are limited to about 50% or less of the chaparral, and leave undisturbed corridors and buffer zones, are more successful than smaller or larger clearings or clearings that alter natural travel routes. Rollerchopping is the preferred method in the mesquite-acacia woodland, as forb density and diversity can be enhanced while encouraging sprouting by shrubs (Everitt 1983, Fulbright and Beasom 1987). Leaving woody plant cover in strips, rather than clumps, can benefit quail and turkey. Maintaining old stands of brush, interspersed with younger, treated stands, maintains cover while stimulating browse for deer (Guthery 1986). However, no more than 40% of the area should be cleared, and clearing should be no more than 250 feet from shrub cover. Trees and shrubs should also be maintained near permanent water and in riparian areas to provide cover to species that use these aquatic bodies, such as turkey, quail, and deer, and to maintain travel corridors (Hauke 1975, Payne and Bryant 1998).

In California, mechanical treatments are used to create openings in chaparral to stimulate growth of grasses and forbs. Treatments also create new edge habitat, although this may be detrimental to birds and other wildlife that need larger patches of chaparral (Soule et al. 1988). Greater bird use has been observed in areas where treatments have left islands of untreated chaparral than areas where large patches of chaparral have been removed and no islands provided (Buttery and Shields 1975). Small, irregular shaped openings are recommended over large blocks. Cutting can be used to stimulate new growth. Disking can be used to open up areas, and bulldozing, chaining, and rollerchopping are sometimes used to prepare sites for burning (Taber and Dasmann 1958, Vallentine 1989).

Mechanical treatments that thin vegetation to reduce hazardous fuels could create openings in dense forest stands that would promote development of understory vegetation, to the benefit of ground- and shrub-dwelling birds and other wildlife in the Marine Ecoregion (Zeedyk and Evans 1975). Thinnings would also increase browse in the understory to benefit deer and elk. Thinnings remove the poor vigor and damaged trees that are most prone to develop cavities that can be used by cavity nesting birds, and bats and other small mammals (Zeedyk and Evans 1975). If some snags and other dead and dying trees were retained, suitable habitat would be provided for species that require cavities.

If harvested material were windrowed or piled, it would provide hiding cover for small mammals and rotting vegetation that could be used by reptiles and amphibians for cover; these species could also forage upon insects and other invertebrates found under this debris.

Effects of Biological Treatments

Containment by Domestic Animals

The grazing discussed in this section refers to "prescribed grazing," which can be defined as the

careful application of grazing or browsing prescriptions (i.e., specified grazing intensities, seasons, frequencies, livestock species, and degrees of selectivity) to achieve natural resource objectives. Livestock production is a secondary objective when using prescribed livestock grazing as a natural resource management tool.

The use of domestic livestock to contain vegetation has a greater likelihood of affecting non-target vegetation than insects and pathogens, but also allows for treatment of larger areas and may stimulate new growth of desirable species. Although grazing animals such as goats, sheep, and cattle are often looked upon negatively in terms of effects on vegetation, they can alter the appearance, productivity, and composition of plant communities to the benefit of wildlife if used in moderation and at appropriate stocking densities (Payne and Bryant 1998). Goats are effective in controlling shrubs such as oaks, mesquite, chamise, and sumac on desert shrublands and chaparral (USDI BLM 1991a). Goats are also effective in controlling vegetation in sensitive areas where use of fire or herbicides is undesirable, such as near residential areas or near streams and wetlands.

Use of domestic livestock in wildlife management must be used carefully, but it is an invaluable and cost-effective management tool if used wisely. Some species, such as black-tailed prairie dogs, and the black-footed ferret that feeds upon these prairie dogs, tend to be more abundant in heavily grazed areas (Koford 1958). Thus, efforts to promote ferret populations include grazing management of prairie dog towns. Livestock can be used strategically to benefit some wildlife by 1) promoting weedy patches for feeding sites for upland birds; 2) promoting grass cover when used in conjunction with rest-rotation grazing; 3) removing dead material; 4) encouraging sprouting by shrubs; and 5) removing competitive vegetation (Urness 1990). Grazing systems that include planned grazing and deferment periods are most successful.

Moderate to heavy grazing can open up shrub and herb layers and make it easier for raptors to locate prey, and can maintain shrub dominance on sites used by mule deer (Smith 1949; Olendorff et al. 1980). Livestock can also be used to maintain residual grass cover, and to create openings in sagebrush cover to benefit greater sage-grouse and their chicks (Crawford et al. 1992).

Other Biological Control Agents

The BLM would use insects and pathogens to control vegetation. The effects of biological treatments using insects and pathogens would be minor. In most cases, the target plants would remain standing, although weakened or unable to reproduce. Over time, the composition of the plant community could change as treated plants died out and native vegetation returned to the area. This would benefit species that favor the native vegetation, but harm species that have adapted to the plant species being treated. Strict controls would be used to ensure that insects and pathogens used in treatments are specific to the target vegetation and do not harm non-target species, as discussed in Chapter 2.

Effects of Chemical Control Treatments

Herbicides are an effective means of controlling weeds and other invasive vegetation. Herbicide treatments and fire use may be the only effective ways to control large areas of annual weeds and other invasive vegetation Sagebrush rangelands are often treated with herbicides to increase herbaceous plants, with herbicides that remove broad-leaved plants without harming grasses being the most widely used. Olson et al. (1994) used low rates of tebuthiuron to thin big sagebrush stands and enhance wildlife habitat in Wyoming. Herbicides such as 2,4-D, picloram, tebuthiuron, and dicamba are used to control woody species such as mesquite, creosote bush, and snakeweed in desert habitats. Where dense canopies are a problem, treatment with triclopyr and clopyralid might be needed to thin woody vegetation. Germano (1978 *cited in* USDI BLM 1991a) observed that jackrabbits, antelope, quail, and lizards favored openings in mesquite stands.

Over three-quarters of herbicide treatments in the Temperate Steppe Ecoregion would be focused on annual and perennial grasses and forbs, including downy brome, leafy spurge, and several species of knapweeds and thistles. Much of this work would be done in support of the BLM's Conservation of Prairie Grasslands initiative to improve grassland habitat for wildlife. Over three-quarters of treatments in the Subtropical Steppe Ecoregion would be focused on sagebrush and other evergreen shrublands, while 12% of treatments would focus on pinyon, juniper, and other evergreen woodland species. Healthy pinyon-juniper woodlands, with a full complement of understory grasses, forbs, and shrubs, provide excellent wildlife habitat. However, in many areas, pinions and junipers have increased in density to the point that understory vegetation is excluded, to the detriment of wildlife

(USDA Forest Service and USDI BLM 2000b). Studies of wildlife use of treated pinyon-juniper habitats have shown that mule deer use was greater in a chemically treated plot than on a mechanically treated plot because herbicide treatment resulted in more openings in the woodlands and a greater retention of screening cover (Severson and Medina 1983).

Herbicides are an important tool for improving forest productivity in the Mediterranean and Marine ecoregions, and studies suggest that the range of wood volume gains from effectively managing forest vegetation (primarily using herbicides) is 30% to 450% for Pacific Northwest forests (Wagner et al. 2004). Herbicides can be effective in improving forest wildlife habitat by 1) reducing populations of invasive exotic plants, 2) creating snags and downed woody material, 3) maintaining patches of early-successional vegetation within late-successional communities, and 4) maintaining woody and herbaceous plant communities for browsing species (Wagner et al. 2004).

The benefits of using herbicides in each ecoregion are described in more detail in the PEIS.

Effects to Special Status Wildlife Species

Public lands in the western U.S. support over 200 species of terrestrial wildlife (including birds, mammals, amphibians, reptiles, mollusks, and arthropods) that have been given a special status based on their rarity or sensitivity. Included are more than 75 species that are federally listed as threatened or endangered, or are proposed for federal listing. Some of these species have habitat requirements that have been or are being altered or reduced by invasions of non-native plant species. The *Final Programmatic Biological Assessment Vegetation Treatments on Bureau of Land Management Lands in 17 Western States* (USDI BLM 2007b) provides a description of the distribution, life history, and current threats for federally-listed animal species, as well as species proposed for listing. The BA also discusses the risks to listed and proposed terrestrial wildlife species associated with vegetation treatments proposed by the BLM.

In general, the potential effects to special status wildlife species from the proposed vegetation treatments would be similar to those described for wildlife as a whole in the previous section. However, the rarity and sensitivity of special status species and their habitats make them more likely to be affected by disturbances associated with treatments. In addition, populations of special status species may in some cases benefit more from fuels reduction and control of non-native species than wildlife species with secure populations.

Standard Operating Procedures

The BLM would implement SOPs to minimize the risks to special status wildlife species from vegetation treatments (see Table 2-5). Examples of SOPs include surveying for species of concern if the project may impact federally and/or state-listed species; minimizing direct impacts to species of concern from fire treatments, unless studies show that these species will benefit from fire; minimizing the use of ground-disturbing equipment near species of concern; and using temporary roads when long-term access to treatment sites is not required. Additional SOPs would be implemented based on the species or habitat present on the treatment site. For example, in western greater sage-grouse habitat, the BLM would minimize off-road vehicle use, minimize fire use, and use treatments to create small openings in continuous or dense sagebrush.

Adverse Effects of Treatments

Fire use and herbicide treatments could harm or kill special status wildlife, especially slow moving species and the eggs and young of ground-nesting or breeding species. Mechanical treatments that disturb soil could also harm burrowing and fossorial species found near the soil surface. All treatments would remove or alter vegetation and could affect the availability and quality of food, cover, and special habitat features needed by wildlife. Treatments could alter other resource conditions (e.g., air quality, soil, water), making them harmful or less suitable for use by special status wildlife. Treatments could also fragment habitats and isolate populations of special status species, especially those unable or unwilling to travel over disturbed ground.

Some special status wildlife species occupy a wide variety of plant community types, as long as they provide adequate food, cover, and breeding habitat. These species tend to be large animals that cover a large geographic area and eat a wide variety of food items, such as gray wolf, grizzly bear, and bald eagle. Although these species could potentially benefit to some degree from weed control, and are typically at low risk for impacts from exposure to herbicide, they could be affected through disturbances associated with vegetation treatments (e.g., presence of workers, trucks/ATVs, and other equipment in their habitat).

Effects of Fire Treatments

The potential for a fire treatment to directly harm special status wildlife would depend on the animal's ability to escape the treatment area. Slow-moving wildlife, such as insects and other arthropods, desert tortoise, and several species of small mammals would be more at risk than species that would be able to flee the area.

Indirect effects to special status species as a result of habitat alteration would depend on the habitat needs of the species. Species that require dense vegetation for cover, such as the southwestern willow flycatcher, riparian woodrat, and Preble's meadow jumping mouse would likely be adversely affected by prescribed burns. For other species, such as the Sonoran pronghorn, fire could potentially reduce the availability of forage in the treatment area, although the new growth after fire would likely be of increased forage quality. Although habitats would quickly recover from fire treatments, the effects of habitat loss to species with non-secure populations could persist over the long term and make populations more susceptible to extirpation. In addition, if a fire treatment were to burn through the entire habitat of a small, isolated population, extirpation of that population could potentially occur. For example, frequent fires were important in maintaining grassland habitat for the Oregon silverspot butterfly, and fire suppression and urbanization have reduced grasslands historically used by this species to a few small remnants. Prescribed fire can help to restore the historic fire regime, but fires also kill the eggs and larvae of the butterfly (Pickering 1997).

Special status species with large home ranges and more general habitat requirements would be unlikely to be affected by fire treatments, provided they did not occur near denning or breeding areas, and human contact was avoided. These species are typically large enough to avoid a treatment area during a burn, and are not specifically dependent on the type or structure of vegetation in their habitat. Examples include gray wolf, grizzly bear, and ocelot.

Effects of Mechanical Treatments

As discussed for wildlife in general, use of mechanical treatments to remove vegetation would run the risk of crushing small animals, including arthropods, reptiles and amphibians, the young and eggs of ground nesting birds, and small mammals. For some special status species, loss of even a few individuals as a result of crushing could substantially increase the susceptibility of the population to future disturbances. Risks would be greatest if treatments occurred over the entire area occupied by a population.

Disturbances associated with mechanical treatments would be substantial, though short in duration. Many mobile animals, such as large adult birds and mammals, could simply leave the area temporarily to avoid the disturbance. Less mobile animals might not be able to leave, particularly if the treatment area was relatively large. In addition, the noise and human presence associated with mechanical treatments would likely cause some animals to temporarily abandon nests. For particularly sensitive species, these disturbances could result in reduced breeding success, which could in turn have population-level effects.

Removal of large stands of vegetation during mechanical treatments could substantially alter the habitat of some special status wildlife species. Although the ultimate result of these treatments would likely be an improvement in habitat quality, the short term stresses on some special status species would outweigh the benefits. If the entire habitat of a special status species was removed during a treatment, extirpation of that population could occur. There would be substantially less risk associated with treatments in a portion of the habitat, provided the untreated habitat was large enough to provide a temporary refuge for the population, and animals and their nests or burrows were not destroyed during the treatment.

Effects of Manual Treatments

Manual treatments would be unlikely to affect mobile animals that could temporarily leave the treatment area. Because manual treatments are not cost-effective for treating large areas, it is unlikely that special status wildlife would have to move far to avoid workers in their habitat. Less mobile animals might not be able to leave the area, resulting in disturbance and stress. These effects should be short term in nature, provided treatments did not require repeated entry into habitat. Some special status wildlife species would be forced to leave nests or young behind temporarily, resulting in a risk of reduced reproductive success to an already sensitive population.

Effects of Biological Treatments

Containment by Domestic Animals. The effects of undesirable vegetation containment by domestic animals on special status wildlife species would depend on numerous factors, including the size and mobility of

the species, the length of the grazing treatment, and whether the domestic animals used would be likely to graze on important forage plants or other required habitat components.

Larger, mobile animals, and birds that nest out of reach of domestic animals should be able to avoid contact with grazers. Less mobile species and young animals, including the eggs of ground nesting birds and butterfly eggs and larvae, would be more susceptible to injury or mortality through trampling and crushing. For special status species with small, at-risk populations, loss of any animals or eggs could reduce the viability of the population, making it more susceptible to extirpation in the future.

Species that originally coexisted with grazers, or that prefer habitats dominated by low, sparsely growing grasses, could potentially benefit from containment of undesirable vegetation by domestic animals, provided nests and burrows were not damaged during treatments. Examples include the blunt-nosed leopard lizard, kangaroo rats, the Utah prairie dog, and the black-footed ferret. In the case of the giant kangaroo rat, moderate levels of grazing by domestic animals have maintained nearly optimum conditions for the species (USFWS 1998).

Special status species that are themselves grazers could be adversely affected by containment treatments by competing with domestic animals for prime forage plants. Effects would be greatest in areas where forage is already limited. Although the ultimate effect could be an increased quantity of preferred forage plants in subsequent years, loss of forage during a single year could have lasting effects on already small and sensitive populations. Effects would be greatest if the treatments occurred over a large area of existing habitat.

Other Biological Control Agents. Use of biological control agents to control weeds could result in minor disturbances to some species from the presence of workers in sensitive habitats (e.g., nesting areas during the breeding season). For most species, these effects would be minor and short term, and would not have lasting effects on populations. Certain special status species, such as piping plovers, are extremely sensitive to human disturbance, and can experience reduced population vigor if disturbed sufficiently. Provided workers did not return repeatedly to the habitats of these species during the breeding season, long-term effects to populations should not occur.

It is not anticipated that use of biological control agents would result in adverse effects to the habitats of special status species. Gradual reduction in weed cover would improve many habitats without causing sudden losses of vegetation or structural changes. There would be some risk associated with using agents that attack plant species that are closely related to species required by special status wildlife for survival (e.g., butterfly host plants). Biological control agents undergo an extensive screening and testing process prior to being permitted by the USDA APHIS program and released. Despite these safeguards, there is always a risk that the release of an agent into a habitat in which it does not normally occur could result in unforeseen ecological harm.

Effects of Chemical Treatments

Terrestrial herbicides with the greatest likelihood of affecting special status wildlife species, via any exposure pathway, include 2,4-D, bromacil, diuron, and hexazinone, which pose moderate to high risks to special status terrestrial wildlife under one or more exposure scenarios involving the typical application rate (see PEIS Tables 4-23 and 4-24). Terrestrial herbicides with the least likelihood of affecting special status wildlife species include chlorsulfuron, diflufenzopyr, imazapic, and sulfometuron methyl, for which no risks to special status wildlife were predicted via any exposure pathway.

Aquatic herbicides with the greatest likelihood of affecting special status amphibian species during a normal application to an aquatic habitat are diquat and some formulations of glyphosate. Normal applications of 2,4-D and imazapyr would not pose a risk to aquatic amphibians. Terrestrial herbicides with the greatest likelihood of affecting special status amphibian species as a result of a spill, drift, accidental direct spray into an aquatic habitat, or surface runoff are bromacil, diuron, and picloram. The following herbicides would pose no risk to aquatic amphibians, according to the ERAs: chlorsulfuron, diflufenzopyr, imazapic, Overdrive®, and sulfometuron methyl.

Beneficial Effects of Treatments

Removal of non-native species and fuels from habitats that support special status wildlife populations would likely provide some degree of benefit to most special status species that occur on public lands by creating more native habitat conditions and reducing the likelihood of a future catastrophic wildfire. The degree of benefit to special status wildlife would depend, in

large part, on the habitat needs of the species and its ability to avoid a fire.

Non-native plant species reduce the suitability of some habitats to support special status wildlife species. For some species, particularly butterflies and moths, certain plant species must be present on a site to serve as larval host plants. Other species require, or at the very least prefer, certain plants as food sources. For example, lesser and Mexican long-nosed bats meet most of their dietary needs from agave and cactus (USFWS 1994, 1995a), and the northern Idaho ground squirrel feeds on native bunchgrasses to fulfill a large portion of its dietary needs (USFWS 2000). Encroachment of non-native plant species, and displacement of native plant species that serve as important sources of food, reduces the suitability of the habitat for these wildlife species. For these species, vegetation treatments would likely provide a long-term benefit to habitat, and could improve the suitability of other areas, potentially creating additional habitat into which the population could expand.

For some special status wildlife species, it is the structure, rather than the species composition of the habitat that makes it suitable. For example, the western snowy plover nests in areas where vegetation is sparse, the Yuma clapper rail is associated with dense marsh vegetation (USFWS 1997), the southwestern willow flycatcher occurs in riparian areas with dense growths of deciduous shrubs and trees (USFWS 1995b), and kangaroo rats require open, grassland conditions. In some cases, invasive plant species alter the structure of habitats, making them less suitable for supporting sensitive wildlife species (e.g., the encroachment of European beachgrass into western snowy plover habitat, or the exclusion of marsh vegetation by saltcedar and arrowweed in Yuma clapper rail habitat). For these species, treatments to control weed infestations would likely provide a long-term benefit. In other cases, non-native plant species may invade an area without making drastic structural changes, and the suitability of the habitat, though not ideal, is maintained (e.g., thickets of saltcedar and Russian olive providing nesting habitat for the southwestern willow flycatcher, or kangaroo rats thriving in annual grasslands dominated by non-native plant species such as red brome). For these species, vegetation treatments may result in some improvement of habitat, but the long-term benefits may not outweigh the short-term risks to the species associated with certain treatment methods.

Some special status wildlife species are more at risk from wildfires than others, particularly species that are not exceptionally mobile and are unable to flee the area or hide in protected refuges such as underground burrows, or are unable to find suitable habitat outside of burned areas. For example, wildfires have burned thousands of acres of northern spotted owl habitat in the Cascade Range (Boroja et al. 1997). Given the limited amount of suitable habitat for this species, it is possible that displaced birds were unable to find suitable habitat nearby and may have perished or suffered reduced productivity, although owls will continue to use traditional use areas where low intensity burns do not kill the overstory and the canopy remains mostly intact (Bevis et al. 1997). These species would receive the greatest long-term benefits from fuels reduction treatments, particularly those with small or fragmented populations, which could be extirpated by a fire.

Fires are often needed to maintain a mosaic of forest habitat types. Northern goshawk habitat in the Southwest is maintained by frequent surface fires that regenerate, clean, and kill forest vegetation. The uneven-age forest structure contains mostly large old trees. Prescribed fires are appropriate for maintaining this type of fire regime. However, forests maintained by catastrophic wildfire result in even-age stand structure and large openings that are not favored by goshawks (Graham et al. 1997). California gnatcatchers require coastal sage-scrub with a shrub canopy cover of 50% or more and average shrub height of 3 feet or more, and avoid recently burned areas. However, this habitat is conducive to wildfire, and use of prescribed fire is an appropriate management tool to control this vegetation, especially when it is found near developed areas. However, if patches of unburned shrubs are left within burned areas, California gnatcatchers will continue to use the burned area (Beyers and Wirtz 1997).

Livestock

Public lands provide an important source of forage for many ranches and help to support the agricultural component of many communities scattered throughout the west. Approximately 165 million acres of public lands are open to livestock grazing, with use levels established by the Secretary of the Interior and administered through the issuance of grazing permits/leases. The majority of the grazing permits issued by the BLM involve grazing by cattle, with fewer and smaller grazing permits for other kinds of livestock, primarily sheep and horses. Many allotments are managed according to an allotment management plan, which outlines how livestock grazing is managed to meet multiple use, sustained yield, and other needs and

objectives, as determined through land use plans. Even if there is no allotment management plan, grazing is managed to ensure that 1) watersheds are in or are making significant progress towards properly functioning physical condition; 2) ecological processes including the hydrologic cycle, nutrient cycle, and energy flow are maintained; 3) water quality complies with state water quality standards; and 4) habitats are, or are making significant progress towards being, restored or maintained for proposed, candidate, or listed federal threatened and endangered species and other special status species.

Many noxious weeds and other invasive plants greatly reduce the land's carrying capacity for domestic livestock. In North Dakota, the value of lands infested with leafy spurge may be a third of that of uninfested lands. In Oregon, the value of a ranch dropped over 80% after it became infested with leafy spurge. Effects to livestock owners occur when weight gains of livestock are reduced, animals are poisoned, or capacity for cattle grazing decreases as a result of weeds. In addition, the costs of treating weeds must be subtracted from the income derived from the sale of animals or their products when figuring net return from a livestock operation (Sheley and Petroff 1998; Rees et al. 1999).

Healthy rangelands that support native grasses, forbs, and shrubs have the capacity to support domestic livestock in addition to wildlife. Altered fire regimes, past grazing practices, and other human-related activities have resulted in rangelands throughout the West that are dominated by invasive annual grasses, forbs, and shrubs, rather than the perennial grasses (with a minor component of forbs and shrubs) that were dominant historically. Even where livestock grazing contributed to the current situation, simply removing domestic livestock or reducing their numbers would not correct this situation. Passive treatments, where the underlying cause of the invasive species problem is identified and eliminated or moderated, and rapid response to weed invasion and spread on rangelands would help, but in many situations, more aggressive treatments are necessary to restore rangeland health (Olson 1999). In some situations, grazing can be used as part of the vegetation treatment program, especially when goats and sheep are used to control vegetation, in addition to domestic cattle.

Scoping Comments and Other Issues Evaluated in Assessment

Some comments suggested that the dangers to livestock from noxious weeds need to be addressed. One respondent inquired about how livestock grazing would be prevented on areas treated with picloram. It was suggested that the BLM provide alternative grazing areas if livestock are displaced for vegetation treatment.

Resource Program Goals

Livestock grazing is important to the economy and social fabric of many rural communities. The Rangeland Management program is primarily responsible for activities involving domestic livestock on public land. Activities within this program include range inventory and monitoring, rangeland health assessments and evaluations, rangeland improvement planning and implementation, and invasive vegetation management. The purpose of vegetation management is to restore native ecosystems that have the capacity to provide a steady source of forage for livestock while meeting the needs of native animals and other uses and resource values (USDI BLM 2006c).

Standard Operating Procedures

Vegetation treatments pose risks to livestock; however, these risks can be minimized by following certain SOPs, which can be implemented at the local level according to specific conditions (see Table 2-5). These SOPs include notifying permittees of proposed treatments and identifying any needed livestock grazing, feeding, and slaughter restrictions. Notifying permittees of the project would improve coordination and help avoid potential conflicts and safety concerns during implementation of the treatment. Scheduling of applications should take into account normal livestock behavior, grazing patterns, and resting periods to minimize impacts to grazing permits. Alternative forage sites for livestock would be provided, if possible.

For herbicide treatments, herbicides of low toxicity to livestock would be used, where feasible. If possible, livestock would be removed from treatment sites prior to herbicide applications. The different types of application equipment and methods would be taken into account to reduce the probability of contaminating non-target food and water sources. These procedures would help minimize effects to livestock and rangeland on public lands to the extent practical. As a result, long-term benefits to livestock from the management of

invasive species would likely outweigh any short-term negative effects associated with herbicide use.

Adverse Effects of Treatments

The proposed vegetation treatments would cause disturbances to rangeland plant communities by killing both target and non-target plants. In areas that have been highly degraded, merely restoring disturbance to the ecosystem could adversely affect native plant communities by encouraging the spread of weeds or the persistence of an altered vegetation structure and species composition. Treatments could require temporary rest from livestock grazing, forcing livestock operators to graze animals elsewhere. Herbicide treatments have the potential to affect the health of livestock.

Downy brome and other annual brome species are the most significant non-native species affecting rangelands in the West due to the sheer number of acres they cover and their site tenacity. Downy brome has a profound effect on sagebrush-grass rangelands because it replaces perennial native species. Once it becomes established, downy brome allows hot fires to occur in spring when perennial grasses are most susceptible to burning, thereby creating conditions favorable for downy brome to achieve dominance. Because downy brome creates fuels for fires, repeated fires eventually occur, which in turn allows downy brome to dominate.

The abundance of downy brome has caused some livestock producers to rely on it as a source of early spring forage. The disadvantage for livestock producers is the narrow window of grazing opportunity and the wide variation of total forage production from year to year.

Effects of Fire Treatments

The effects of fire on livestock would depend largely on the timing of the fire and the pre-burn condition of the site. Over the short term, prescribed burning would likely reduce the cover of grass and forb species available to livestock. Livestock would also have to be relocated during the treatment. In addition, livestock would need to be kept off of treated areas for a short time after a prescribed fire to give forage ample time to recover. The length of time would vary by site, but would generally range from two to four growing seasons (Stinson 2001).

The burning of rangeland generally results in increased perennial grass production and grazing capacity as well as increased forage availability from the removal of physical obstructions posed by brush and small trees. Following fire, there may be greatly increased amounts of flowering and fruiting, including a significantly enhanced output of grass seed (Daubenmire 1975, Christenson and Muller 1975, Young 1986 *cited in* USDI BLM 1991a). The amount of flowering and fruiting may decrease over prefire levels for some time if plants are severely damaged by fire.

Effects of Mechanical Treatments

Use of mechanical treatments could temporarily reduce the amount of livestock forage on the treatment site. Treatments that rip up plants, such as bulldozing or chaining, would be more likely to reduce forage than treatments that cut plants off at the base. These effects would be short-term in nature, as forage species would regrow following treatments.

Mechanical methods that remove competition and overstory vegetation would be expected to enhance grass production if grasses are present on the site. However, mechanical removal could negatively affect plants by compacting soils, creating bare ground, and uprooting desirable species. Ground disturbance could provide increased opportunities for weeds and increase the need to reseed after treatment.

Effects of Manual Treatments

Manual treatments would have minimal effects on livestock and their forage. Manual treatments would target the removal of undesirable species, but would not affect desirable species. Therefore, any effects on livestock forage would be beneficial.

Effects of Biological Treatments

Containment by Domestic Animals

Use of domestic animals to manage undesirable vegetation could affect the livestock that regularly graze on public lands under a grazing permit or lease. When managed improperly, these animals could compete for the same forage resources as domestic livestock. Under proper conditions, it has been demonstrated that the use of sheep and goats to manage leafy spurge through prescribed grazing has improved the conditions of the range, opening up infested sites for grass regrowth, and thus providing additional forage for authorized livestock grazing.

Other Biological Control Agents

Insects and pathogens released to manage noxious weeds on rangelands would not be likely to affect livestock. These agents target undesirable species, and could result in a long-term increase in the quality of forage on a treatment site. However, it is possible that in some situations use of these agents could prohibit animals from using a pasture for short periods of time.

Effects of Chemical Treatments

The extent of direct and indirect effects to livestock from herbicide treatments are evaluated in the PEIS (USDI BLM 2007a). Several factors influence the effectiveness of the herbicide application, including timing and method of application, herbicide used, application site characteristics, and environmental conditions. The direct effects of herbicide use on livestock depend on the sensitivity of each species to the particular herbicide used. Indirect effects include the degree to which a species or individual is positively or negatively affected by changes in rangeland conditions.

Livestock would have a greater chance of being affected by herbicide use if their range extent was completely treated or areas frequented by the livestock were treated. However, livestock could be specifically removed from an area during vegetation treatment, as directed on the herbicide label, or treatments could be scheduled to occur when livestock were not present, adhering to the re-entry interval specified on the herbicide label. If livestock were removed from the area specifically to facilitate the vegetation treatment, the grazing permittee would be adversely affected as a result of the area being unavailable for grazing. The permittee would need to either find alternative grazing areas, or modify ranching operations to account for the unavailable forage. Even though large treatments would usually occur when livestock were not in the treated area, some risk of indirect contact and consumption of contaminated vegetation over a large area would still exist. The use of spot treatment applications, in accordance to label directions, would reduce the potential effect on livestock. The effects of herbicide use on livestock would be site and application specific, and as such, site assessments would have to be performed, using available information, to determine an herbicide-use strategy that would minimize effects to livestock.

The BLM and Forest Service risk assessments suggested several possible common effects of herbicides to livestock (ENSR 2005c-l; SERA 2005). Livestock, which likely consume large quantities of grass, have greater risk for harm than livestock or wildlife that feed on other herbaceous vegetation or seeds and fruits, because herbicide residue is higher on grass than it is on other plants (Fletcher et al. 1994; Pfleeger et al. 1996). However, exposure to harmful doses of herbicide would be unlikely, since animals would be removed from the area if there was a chance they could be harmed by an herbicide, as required by the label instructions.

In conjunction with the identified grazing restrictions listed on herbicide labels, additional restrictions may be identified that require the livestock owner to remove the livestock from the treated area for a specified period of time prior to slaughter. In reviewing the grazing and slaughter restrictions listed on herbicide labels, it is important to recognize that additional grazing restrictions may apply to grazing lactating dairy animals. As described for other vegetation treatment methods, some herbicide treatments may require additional rest from livestock to ensure that more desirable vegetation has the opportunity to increase and reestablish on those sites from which undesirable vegetation has been removed.

Beneficial Effects of Treatments

All treatments that successfully reduce the cover of noxious weeds on rangelands would benefit livestock by increasing the number of acres suitable for grazing and the quality of forage. Noxious weed infestations can greatly reduce the land's carrying capacity for domestic livestock, which tend to avoid most weeds (Olson 1999). Cattle, in particular, preferentially graze native plant species over weeds, which often have low palatability as a result of toxins, spines, and/or distasteful compounds (Young 1992, Beck 1999, Olson 1999). Although goats and sheep are more likely to consume alien weeds than cattle, they also tend to select native or introduced forage species over weeds (Walker et al. 1994; Olson and Wallander 1998; Olson 1999). In addition, some noxious weeds (e.g., common tansy, houndstongue, Russian knapweed, and St. Johnswort) are poisonous to livestock. The success of weed removal would determine the level of benefit of the treatments over the long term.

Treatments that reduce the risk of future catastrophic wildfire through fuels reduction would also benefit livestock. Uncontrolled, high intensity wildfires can damage large tracts of rangeland, reducing its suitability for livestock grazing. Wildfires typically occur during drought conditions, when burning rangeland magnifies

the drought stress of forage species and hampers their recovery. Treatments that restore and maintain fire-adapted ecosystems, such as the appropriate use of mechanical thinning and fire, would decrease the effects from wildfire to rangeland plant communities and improve ecosystem resilience and sustainability.

Fire suppression causes a buildup of dead plant materials (e.g., litter), and often increases the density of flammable living fuels on a site. The resultant fires burn hotter, spread more quickly, and consume more plant materials than fires that historically occurred under conditions of lower fuel loading. Large fires in the Great Basin during the late 1990s burned grazing allotments, eliminating much of the forage for livestock. If burned sites are not restored, weeds invade damaged areas and displace grasses favored by livestock. Therefore, restoring rangeland after fire helps increase forage for livestock (USDI BLM 1999).

Treatments that control populations of non-native species on public lands would be expected to benefit native plant communities by reducing the importance of non-native species and aiding in the reestablishment of native species. The use of fire, herbicides, or other treatment methods to simply kill vegetation is often inadequate, especially for large infestations. Introducing and establishing competitive plants is also needed for successful management of weed infestations and the restoration of desirable plant communities (Jacobs et al. 1999). The degree of benefit would depend on the success of these treatments over both the short and long term. Some treatments are very successful at removing weeds over the short term, but are not successful at promoting the establishment of native species in their place. In such cases, seeding of native plant species would be beneficial. Weeds may resprout or reseed quickly, outcompeting native species, and in some cases increasing in vigor as a result of treatments. The success of treatments would depend on numerous factors, and could require the use of a combination of methods discussed below to combat undesirable species.

Effects of Fire Treatments

In many cases, fire would benefit livestock by reducing the cover of shrub species such as sagebrush and juniper, which can form dense stands that preclude the establishment of desirable forage species and create physical obstructions to forage. The effect of fire on forage would vary by site. Fires conducted during the dormant season, under moist conditions, would be likely to stimulate forage production (e.g., through increasing soil temperature and nutrient availability) and favor perennial grasses (Wright 1974). Cattle have been observed to preferentially graze burned areas over unburned areas, with greater weight gains observed in animals that graze on burned sites (McGinty et al. 1983). In contrast, burning during the early summer can kill bunchgrasses and favor undesirable annuals, such as downy brome. In addition, suitable forage must be present on the site prior to the burn in order for livestock to benefit from the fire. In sites that are in poor condition, a combination of treatments and/or reseeding may be required to benefit livestock.

Effects of Mechanical and Manual Treatments

Livestock could benefit from a reduction in woody species and other undesirable vegetation. The duration of these benefits would depend on the species' ability to resprout, which could be controlled by using a combination of treatments (e.g., mechanical treatments plus fire or herbicides). Where woody species do resprout quickly, their palatability could be improved in the form of new growth.

Effects of Biological Control Treatments

Insects and pathogens have been used to control rangeland weeds and other invasive plants that are poisonous to livestock and that displace more desirable forage species. For example, flea beetles have reduced leafy spurge stem densities by 90% or more, and over 80% of flea beetle introductions have become established (Team Leafy Spurge 1999). It is estimated that 60% to 70% of leafy spurge infestations will be controlled using biological control by 2025 (Bangsund et al. 1997). Beetles, moths, flies, and other insects and pathogens have been used to control knapweeds, yellow starthistle, St. Johnswort, tansy ragwort, thistles, and other weeds that make rangeland unsuitable for livestock and may be poisonous to animals.

Effects of Chemical Treatments

In cases where herbicide treatments are able to reduce the cover of noxious and unpalatable weeds on grazed lands, there would be short- and long-term benefits to livestock as a result of increased quality of forage. In some cases, herbicides are the most effective means of controlling or eradicating invasive plant species.

The extent of positive and negative effects to livestock would depend on the relative amount each herbicide was used, whether herbicides would be applied in rangeland environments, and the method of application. The risk of negative effects would be greatest if diuron,

diquat, bromacil and/or 2,4-D were used extensively. However, diquat would be used by the BLM exclusively as an aquatic herbicide, and the non-selective herbicides bromacil and diuron are not likely to be used extensively in rangelands. If these herbicides were used in restricted scenarios, as is proposed, and other herbicides were used effectively to increase the abundance of native forage relative to unpalatable weeds, positive effects to livestock could outweigh negative effects. Furthermore, the ability to use the four new herbicides proposed for use (diquat, fluridone, imazapic, and Overdrive®), as well as future herbicides that become registered with the USEPA, would allow BLM managers more options in choosing herbicides that best match treatment goals and application conditions and that are less toxic. As a result, there could be an increase in per capita benefits and a reduction in overall per capita risks to livestock (three of the four new herbicides present little to no risk to livestock) and an increase in habitat and ecosystem benefits from treatment.

Wild Horses and Burros

The BLM, in conjunction with the Forest Service, manages wild horses and burros on BLM- and Forest Service-administered lands through the *Wild Free-Roaming Horse and Burro Act of 1971*. Animals are managed within 201 Wild Horse and Burro herd management areas, with the goal of managing self-sustaining populations of healthy animals in balance with other uses and the productive capacity of their habitat. Public lands inhabited by wild horses or burros are closed to grazing by domestic horses and burros under permit or lease. In February 2005, over 31,000 wild horses and burros lived on public lands, with nearly half of these animals living in Nevada. The population of wild horses and burros is currently 3,500 animals above the appropriate management level. The appropriate management level is the number of wild horses and burros that public lands can support while maintaining a thriving natural ecological balance.

Vegetation management activities could affect wild horses and burros by exposing them to fire and chemicals that could harm their health, or by causing changes in vegetation that could positively or negatively alter the carrying capacity of the herd management areas. Alternately, vegetation management activities could improve the amount and quality of forage, potentially increasing the carrying capacity of the herd management areas.

Scoping Comments and Other Issues Evaluated in Assessment

Numerous respondents indicated that evaluation of the direct effects of herbicides to wild horses and burros would help in the selection of less-toxic herbicides, where feasible. Respondents were also concerned about how treatments would improve ecosystem health to benefit wild horses and burros.

Resource Program Goals

The goal of the Wild Horse and Burro Management program is to manage for self-sustaining populations of healthy animals in balance with other uses and the productive capacity of their habitat. The BLM manages populations by monitoring the animals, establishing appropriate population levels, and removing animals when appropriate population levels are exceeded. Given that populations increase by 15 to 20% annually, it is necessary to remove animals to maintain populations at a level that does not adversely affect rangeland vegetation (USDI BLM 2006c). This helps to promote healthy rangelands for all users. Vegetation treatments that improve rangeland would ensure healthier herds and could allow for an increase in the numbers of animals that could be maintained on public lands without harming ecosystem health.

Standard Operating Procedures

There are potential risks to wild horses and burros associated with herbicide use. However, these risks can be minimized by following certain SOPs, which can be implemented at the local level according to specific conditions: 1) minimizing potential hazards to wild horses and burros by ensuring adequate escape opportunities; 2) minimizing use of herbicides in areas actively grazed by wild horses and burros and/or using herbicides of low toxicity to horses and burros to reduce potential impacts; 3) removing wild horses and burros from identified treatment areas prior to herbicide application, in accordance with label directions for livestock; and 5) taking into account the different types of application equipment and methods to limit the probability of contaminating non-target food and water sources.

In addition the BLM should minimize potential hazards to horses and burros from all treatment methods by ensuring adequate escape opportunities, and 2) avoid critical periods and minimize impacts to critical habitat

that could adversely affect wild horse or burro populations (see Table 2-5).

These procedures would help to minimize effects to wild horses and burros and rangeland to the extent practical. As a result, long-term benefits to wild horses and burros from the control of invasive species would likely outweigh any short-term negative effects to these animals associated with vegetation treatments.

Adverse Effects of Treatments

The proposed vegetation treatments would cause disturbances to rangeland plant communities by killing both target and non-target plants. In areas that have been highly degraded, merely restoring disturbance to the ecosystem could adversely affect native plant communities in some cases by encouraging the spread of weeds or the persistence of altered vegetation structure and species composition. Treatments also have the potential to adversely affect the health of wild horses and burros.

Effects of Fire Treatments

Fire treatments occurring in herd management areas would have the potential to affect wild horse and burro herds in those areas. Direct effects to animals from fires would be unlikely, as they would be able to flee the burn area. With large fires, wild horses or burros may be forced onto areas that are not legally designated for wild horse and burro management.

Over the short term, fire could reduce the suitability of the treatment site to support wild horses and burros. The degree of effects would be dependent on the size and severity of the fire, the climatic conditions, and any other animals (i.e., domestic livestock or wildlife) using the site for grazing purposes. A large fire that consumed much of a herd management area could potentially result in a loss of animals, unless herds were temporarily relocated prior to treatment. In the case of a small, low severity fire, wild horses and burros would be likely to find suitable forage in the area. Wild horses are accustomed to migrating in search of food and shelter in response to climatic variation and natural disturbances that alter food supplies (Nevada Commission for the Preservation of Wild Horses 1999). Food stresses to populations following prescribed fire would be the greatest on sites occupied by large populations of other domestic animals, or during harsh climatic conditions, such as drought.

Effects of Mechanical Treatments

Use of mechanical treatments could temporarily reduce the amount of forage on the treatment site, as discussed for livestock in the previous section. Long-term benefits to forage production could also occur. In addition, wild horses and burros could experience short-term disturbances associated with mechanical noise and the presence of humans. However, since animals could leave the area during treatments, effects would be minor.

Effects of Manual Treatments

Manual treatments would have minimal effects on wild horses/burros or their forage, as they would occur over a very small area and target undesirable forage species.

Effects of Biological Treatments

Containment by Domestic Animals

The use of domestic animals to control vegetation could result in minor competition with wild horses and burros. However, these effects would be localized and short-term in duration, and should not adversely affect wild horse and burro populations. Wild horses and burros are more generalists in regards to their feeding behavior than domestic livestock, and would graze over a larger area than animals brought in for treatments.

Other Biological Control Agents

Insects and pathogens that target noxious weed species would be unlikely to affect populations of wild horses and burros. These treatments target undesirable forage species, would generally not harm desired non-target species, and are slow-acting.

Effects of Chemical Treatments

The extent of direct and indirect impacts to wild horses and burros would be influenced by several factors, including the herbicide selected for treatment, the species composition of the site to be treated, the type of application, the physical characteristics of the treatment area, environmental conditions, and the timing of the application in relation to the behavior of the wild horses and burros. The impacts of herbicide use on wild horses and burros would depend directly on the sensitivity of each species to the particular herbicide used and indirectly on the degree to which a species or individual is positively or negatively affected by changes in herd management area conditions.

Adverse indirect effects could include reduction in forage amount and preferred forage type. If their range extent was partially or completely sprayed, wild horses and burros would be at risk for exposure to herbicides directly via contact with the herbicide upon application, or indirectly via dermal contact with or ingestion of sprayed vegetation. It is unlikely that an animal's entire range would be sprayed, as these animals are wide ranging; herd management areas are often larger than 10,000 acres, while most (77%) of treatments would be less than 1,000 acres. On average, wild horses and burros use about 360 acres per animal, or about 3,600 acres for a herd of 10 animals.

The BLM and Forest Service risk assessments assessed the risks of herbicides to wild horses and burros (ENSR 2005c-l; SERA 2005). Wild horses and burros, which likely consume large quantities of grass, have relatively greater risk for harm than smaller wildlife or wildlife that feed on other herbaceous vegetation or seeds and fruits because herbicide residue is higher on grass than it is on other plants (Fletcher et al. 1994; Pfleeger et al. 1996). However, exposure to harmful doses of herbicide would be unlikely since animals would cover a large area during their daily movements, and thus would likely be exposed only to small amounts of herbicide.

Beneficial Effects of Treatments

All treatments that successfully reduce the cover of noxious weeds on grazed lands would benefit wild horses and burros by increasing the acreage available for grazing and the quality of forage. In addition, some noxious weeds (e.g., common tansy, houndstongue, Russian knapweed, and St. Johnswort) are poisonous to wild horses and burros. The success of weed removal would determine the level of benefit of the treatments over the long term.

Treatments that reduce the risk of future catastrophic wildfire through fuels reduction would also benefit wild horses and burros. Weeds of concern that could be found in rangelands include downy brome, medusahead, halogeton, rabbitbrush, diffuse knapweed, Russian thistle, and perennial pepperweed. Much of the herd management area land for wild horses and burros occurs in drier habitats in Nevada. Uncontrolled, high intensity wildfires can damage large tracts of rangeland, reducing its suitability for wild horse and burro grazing. Wildfires typically occur during drought conditions, when burning rangeland magnifies the drought stress of forage species and hampers their recovery. Some herbicides are approved for use in BLM programs for rangeland as well as fuels management (e.g., glyphosate, imazapic, and sulfometuron methyl). Treatments that remove dominant woody vegetation, particularly pinyon and juniper that have invaded shrub-grass habitats, would enhance habitat for wild horses and burros as grasses and forbs establish.

Effects of Fire Use

In the growing seasons following fire treatments, wild horses and burros would be able to return to treated sites. The condition of forage on the site would depend on the condition of the site prior to treatment and the response of the vegetation type receiving fire treatments. Improved forage would be likely as a result of fires conducted during the dormant season and under moist conditions.

Effects of Mechanical and Manual Treatments

In some cases, wild horses and burros would benefit from the reduction in woody species and other undesirable vegetation. The duration of these benefits would depend on the species' ability to resprout, which could be controlled by using a combination of treatments (e.g., mechanical treatments plus fire or herbicides). Where woody species did resprout quickly, their palatability could be improved in the form of new growth. Shrubs are an important component of the diet of wild horses and burros, especially during winter (USDI BLM 2001a).

Effects of Biological Treatments

Insects and pathogens have been used to control rangeland weeds and other invasive plants that are poisonous to wild horses and burros and that displace more desirable forage species. Beetles, moths, flies and other insects and pathogens have been used to control knapweeds, yellow starthistle, St. Johnswort, tansy ragwort, and thistles; these unpalatable or poisonous plant species make rangeland less desirable for wild horses and burros.

Effects of Chemical Treatments

In cases where herbicide treatments reduce the cover of noxious and unpalatable weeds on grazed lands and replace them with more palatable native plants, there would be associated short- and long-term benefits to wild horses and burros from increased availability and quality of forage. If the forage amount was increased within a given herd management area, the carrying capacity of the herd management area would increase,

thus benefiting those areas where wild horse and burro populations exceed the appropriate management level.

The use of herbicides, or a combination of herbicides in conjunction with another treatment method, may be the most effective means of controlling or eradicating some invasive plant species. Noxious weed infestations can greatly reduce the land's carrying capacity for wild horses and burros, which tend to avoid weeds that have low palatability as a result of defenses such as toxins, spines, and/or distasteful compounds (e.g., thistle [Olson 1999]). In addition, some noxious weeds (e.g., horsetail, wild mustard, poison hemlock, tansy ragwort, yellow starthistle, and St. Johnswort) are poisonous to horses. Grazing alone can be an effective means of managing invasive plants in herd management areas. However, if vegetation is overgrazed (e.g., as a result of herd management areas in excess of the appropriate management level) another method, such as herbicide treatment, is required to return vegetation to a more desirable composition, followed by grazing within the carrying capacity of the herd management area. The success of weed removal would determine the level of benefit of the treatments over the long term.

The ability to use the four new herbicides (diquat, fluridone, imazapic, and Overdrive®), as well as future herbicides that become registered with the USEPA, would allow BLM managers more options in choosing herbicides that best match treatment goals and application conditions and are the least toxic. As a result, there could be an increase in per capita benefits and a reduction in overall per capita risks to wild horses and burros (three of the four new herbicides present little to no risk to wild horses and burros), and an increase in habitat and ecosystem benefits from treatment.

Paleontological and Cultural Resources

As discussed below, wildfire has the potential to adversely affect paleontological, cultural, and traditional lifeway resources by destroying and altering resources. It is likely that invasive infestations have long-term negative effects on paleontological and cultural resource sites by altering native plant communities and increasing the potential for soil erosion, potentially leading to the loss of paleontological and cultural resources. Restoration of natural fire regimes and removal of invasive vegetation would limit these effects as well as contribute to the restoration and maintenance of historic and ethnographic cultural landscapes (USDI National Park Service 2003).

Scoping Comments and Other Issues Evaluated in Assessment

Some respondents felt that cultural preservation is an important issue, and encouraged addressing the effects to cultural and archaeological sites. Other respondents suggested that traditional cultural properties should be approached in a way that is sensitive to cultural resources, with plan revisions and, in some cases, by project cancellation. There was concern about the effects of herbicides on basket plants and the people who collect them, in particular Native peoples. Plant parts are sometimes placed in the mouth for cutting, splitting, or softening, which can result in ingestion of contaminants. Respondents noted that fire generally helps these basket plants, while herbicides are detrimental.

Resource Program Goals

The management of cultural and paleontological resources on public lands is overseen by the BLM's Cultural and Fossil Resources and Tribal Consultation programs. Goals of the programs include: 1) protection, study, management, and stabilization of the BLM's cultural and paleontological resources; 2) interpretation of these resources; 3) protection and curation of museum collections recovered from on-the-ground investigations; 4) consultation with Indian tribes and Alaska Native corporations; 5) development of partnerships with non-federal entities; and 6) repatriation of museum collections subject to the provisions of the Native American Graves Protection and Repatriation Act.

As discussed below, vegetation treatment activities could have substantial effects on paleontological and cultural resources and Native American traditional lifeway values. Thus, the program has a keen interest in ensuring that vegetation treatments are conducted in a manner that protects or enhances these resources while improving vegetation condition.

Standard Operating Procedures

Before proceeding with vegetation treatments, the effects of BLM actions on cultural resources would be addressed through compliance with the NHPA, as implemented through a 1997 national Programmatic Agreement (*Programmatic Agreement among the*

Bureau of Land Management, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers Regarding the Manner in Which BLM Will Meet Its Responsibilities Under the National Historic Preservation Act) and state-specific protocol agreements with SHPOs. Effects on paleontological resources would be addressed as outlined in resource management plans developed under the authority of the FLPMA, and site specific NEPA documents developed for vegetative treatments. The BLM's responsibilities under these authorities would be addressed as early in the vegetation management project planning process as possible.

The processes for identifying and managing cultural resources are addressed in USDI BLM manuals 8100 *(The Foundations for Managing Cultural Resources*), 8110 *(Identifying and Evaluating Cultural Resources),* 8120 *(Tribal Consultation under Cultural Resource Authorities*), 8130 *(Planning for Uses of Cultural Resources)*, 8140 *(Protecting Cultural Resources)*, and Handbook H-8120-1 *(Guidelines for Conducting Tribal Consultation)*. Processes for identifying and managing paleontological resources are outlined in Manual 8720 (*Paleontological Resource Management*) and Handbook H-8720-1 *(General Procedural Guidance for Paleontological Resource Management)*. The BLM Cultural Resource Management program is responsible for the study, evaluation, protection, management, stabilization, and inventory of paleontological, historical, and archeological resources. The program also guides close consultation with American Indian tribal and Alaska Native group governments as required by law for the maintenance, preservation, and promotion of native cultural heritage and resources, including plant and animal subsistence resources and vegetation used for religious and ceremonial purposes. The BLM initiated consultation with American Indian tribes and Alaska Native groups to identify their cultural values, religious beliefs, traditional practices, and legal rights that could be affected by BLM actions. Consultation included sending out letters to all tribes and groups that could be directly affected by vegetation treatment activities, and requesting information on how the proposed activities could affect Native American and Alaska Native interests, including the use of vegetation and wildlife for subsistence, religious, and ceremonial purposes (see Appendix C).

Paleontological Resources

The processes for identifying paleontological resources would include consultation with BLM regional paleontologists, paleontology program contacts in BLM field offices, state geological survey agencies, local colleges, universities, or museums, or SHPOs (if individual SHPOs deal with fossil resources) as part of the planning process. Procedures would be developed for protecting significant fossil resources as outlined in BLM Handbook H-8270-1 (*General Procedural Guidance for Paleontological Resource Management)*. Resource management plans may be in place that have classified sensitivity levels for important fossil resources and management prescriptions associated with each sensitivity level. Specific protective measures for paleontological resources would be identified at the local level during project development. If management plans lack this classification scheme, project specific analysis would be necessary to assess the need to conduct paleontological resource inventories based on available information. If a project area contained documented locations of paleontological resources, or had geological or geomorphic characteristics likely to contain vertebrate fossils, a field inventory could be required to locate and report previously unrecorded paleontological resources. Site specific mitigation measures would be developed during the implementation stage of the vegetation treatments, if needed.

Cultural Resources

Treatments would follow standard procedures for identifying cultural resources in compliance with Section 106 of the NHPA, as implemented through the national programmatic agreement and state protocols. The process would include necessary consultations with SHPOs and interested tribes, at the state or local level, as projects were planned.

As part of the process of planning for vegetation treatments, cultural resource specialists would identify historic properties eligible for the NRHP. Historic properties may include any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP. Effects to National Register-eligible cultural resources could be avoided through project redesign or could be mitigated through recordation, data recovery, monitoring, or other appropriate measures. Should National Register-eligible cultural resources be inadvertently discovered during vegetation treatments, appropriate actions would be taken to protect these resources or recover data following appropriate consultation. An important concern regarding the presence of non-cultural resource personnel on the ground during any of the treatment processes is the unauthorized collection of artifactual material, especially from National Register-eligible

properties. Procedures would be developed as part of an unanticipated discoveries plan that would include reporting previously unrecorded cultural resources to local BLM professionals. Ancestral tribal human remains and associated grave goods subject to the Native American Graves Protection and Repatriation Act would be further reported to appropriate American Indian tribes by local BLM officials.

Traditional Lifeway Values

Discussions would be held with American Indian tribes and Alaska Native groups to determine which plants with the potential to be affected by proposed project treatments have traditional lifeway values, and to identify any specific, traditional collecting areas. Target plants for vegetation treatments include oak, juniper, pinyon, lodgepole pine, cottonwood, mesquite, amaranth, cattail, and brackenfern, as well as many other plants identified in Native American ethnobotanical studies and pharmacopoeia. These plants are traditionally used for subsistence, clothing, basketry, shelter, utilitarian items, and possibly medicines by one or more tribes or groups in the western U.S. and Alaska. Since other target species have common names similar to those of some plants used traditionally, such as whorled milkweed or giant reeds, this should be made clear to Native Americans and Alaska Natives in areas where treatments are planned. Treatments that could adversely affect plants important for maintaining traditional lifeways could be modified or cancelled in certain areas, depending on the intensity of the effects as determined through NEPA analysis and if mitigation is required. On the other hand, there could be long-term benefits to traditional lifeways, since reducing or eliminating non-native or invasive plant competitors could allow traditionally used native species to proliferate, and possibly also improve access for tribal uses. Prescribed fire produces new growth that can benefit plant species desired for traditional tribal practices, such as basket weaving.

Adverse Effects of Treatments

Treatment activities that disturb the ground or alter the distribution, health, and welfare of plants and animals used by Native peoples would result in the greatest potential to harm paleontological, cultural, and traditional use resources. One third of acres would be treated using fire, which has both short- and long-term effects, including beneficial effects, on resources important to Native peoples. Another third of the acres would be treated using mechanical methods. Ground disturbance associated with mechanical treatments could affect artifacts located near the soil surface. Other treatment methods would have little effect on paleontological, cultural, and subsistence resources, although herbicide treatments could harm non-target vegetation and the health of Native Americans, and could alter cultural landscapes associated with historic properties.

Effects of Fire Treatments

There are several good sources of information on the effects of fire on cultural and paleontological resources, including the *Fire Effects Guide: Cultural Resources* (Hanes 2001), *Bibliographic Sources Regarding the Effects of Fire on Cultural Properties* (Halford 2001), and the *Bare Bones Guide to Fire Effects on Cultural Resources for Cultural Resource Specialists* (Winthrop 2004). These sources were used to prepare the following discussion on the effects of fire on cultural resources.

The effects of fire on cultural resources would vary depending on temperature and duration of exposure to heat. Generally, higher temperature and/or longer exposure to heat increases the potential for damage to cultural resources. As a general rule, fire does not affect buried cultural materials. Studies show that even a few inches of soil cover are sufficient to protect cultural materials (Oster n.d.). However, there are times when conditions do carry heat below the surface, with the potential to affect buried materials.

Stumps that smolder and burn have the potential to affect nearby buried materials. Heavy duff, surface logs, and roots that smolder and burn have the potential to expose subsurface materials to heat over a period of time, and hence have the potential to affect cultural materials. Fires that burn hot and fast through a site may have less of an effect on certain types of cultural materials than fires that smolder in the duff, or than logs that burn for a period of time.

Some effects of fire on certain cultural materials may be insubstantial. That is, the fire might not actually diminish characteristics that make a site eligible for the NRHP. For example, although high heat could destroy obsidian hydration bands on surface artifacts, the surface component of the affected site might not be of particular value in the site's overall assessment. Fire could burn the solder out of a hole-in-cap can without diminishing the can's ability to provide chronological information for a site.

Wildland fire is generally more destructive to cultural resources than prescribed fire, since it results in effects from both uncontrolled fire and fire suppression. Management decisions may need to balance the potential effects of a prescribed burn with the risk of damage from an uncontrolled wildfire. Because prescribed fire can be controlled, cultural resource specialists could work with fire managers to determine the predicted temperature and duration of a fire through an area, and possibly to modify burn plans to minimize effects to cultural resources. The emergency nature of wildland fires can lessen management ability and priority to conserve cultural resources.

Protecting cultural resources during fire would begin with fire management planning. During planning, the BLM would define vulnerable cultural resources by classes of site-types and specific sites, identify appropriate protection measures for them, and identify appropriate management responses with regard to cultural resources in the event of fire. Consultation with SHPO, Tribes, and other appropriate entities should be part of the project planning process, especially when designing fire-specific protocols for identification and protection of potentially affected cultural resources.

Fire Effects on Lithics

Fire can affect chipped and groundstone tools, primarily through changes in morphology rather than in chemistry. Residues on artifacts are not necessarily destroyed by fire. As a general rule of thumb, the hotter the temperature and the longer the exposure to fire, the greater the effect on lithic materials. When important artifacts are present in a treatment site, it could be necessary to take protective measures.

Obsidian. Fire can modify or destroy obsidian hydration rinds, but does not affect obsidian source analysis (Shackley and Dillian 2002). High temperatures, such as those experienced in a catastrophic wildfire, may be sufficient to cause obsidian to bubble and crack, losing shape as well as hydration capacity.

The exact temperature at which obsidian is affected varies, probably due to components of the field environment and/or differences in source materials. Duration of exposure increases the effect of heat on obsidian. High temperatures and smoldering fires can affect hydration bands, diminishing or obliterating them.

Chert. Fire can affect chert (including various silicates), through fracturing, pot-lidding, crazing, shattering, causing changes in color and internal luster, and other effects that might reduce an artifact's ability to render information about the past. Temperatures that affect chert vary and are possibly dependent on source or other variables such as prior heat-treatment for tool manufacture. Generally, the longer and hotter the fire, the more intense the effects on chert artifacts would be (Deal n.d.; Winthrop 2004). After a fire, it may be more difficult to distinguish whether chert artifacts were subjected to purposeful heat-treatment in the original manufacturing process.

Basalt. Fire can produce changes in basalt, including spalling, potlidding, crazing, and fracturing that possibly result from rapid cooling. There is little experimental data for fire effects on basalt. One study indicates that spalling or flaking may occur at temperatures around 662 ºF to 752 ºF (Deal n.d.). Peak production of combustible products from fire occurs above 600 ºF.

Groundstone. Rock types vary in their response to fire. Sandstone reportedly cracks or fractures at a lower temperature than basalt. Granites and quartzites withstand higher temperatures. Severe wildfire may cause portable groundstone to crack or fracture. Thermal shock, such as rapid heating or cooling, can cause fracturing and exfoliating of groundstone artifacts, including bedrock mortars. Burning or smoldering fuels on groundstone artifacts or features (e.g., a fallen tree on a bedrock mortar) may contribute to increased damage during a fire. As is true for other tool types, longer exposure to heat and/or hotter fires increases the potential for artifact damage (Deal n.d.; Buenger 2003).

Fire Effects on Ceramics

Because of the different types of clays, inclusions, and manufacturing techniques, the effects of fire are different for different distinct pottery types. Since all pottery—historic and prehistoric—has been fired to some degree, heat damage is not as significant a consideration for this artifact type as it is for others. Generally, structural damage does not occur until temperatures exceed the original firing temperature. Most damage noted is to the surface decoration or glaze. Archaeological ceramic manufacturing facilities, like archaeological hearths, may have characteristics that could be altered or damaged by fire; thus, fire can potentially damage their suitability for dating by thermo-luminescence techniques.

Prehistoric Ceramics. Temperatures do not exceed the original firing temperature for most prehistoric ceramics until about 1,112 °F (Andrews 2004). Fire can, however, affect the appearance of pottery shards, possibly leading to misidentification. Effects from fire include surface spalling, alteration of painted decoration, blackening and sooting, and loss of appliqué designs, which may break off. In one experiment painted designs faded and changed color at temperatures greater than 1,472 °F. However, sooting or blackening may be removed by cleaning in a lab, and discoloration does not necessarily prevent identification of pottery type (Rude n.d). Fire-altered ceramic fragments may make field location of actual ceramic manufacturing facilities or sites more difficult, as such processes are identified by the presence of "waste fragments," the by-products of pottery production.

Historic Ceramics. Historic ceramics consist of earthenwares, stonewares, and porcelain. These types of pottery are differentiated in part by the heat of firing. All of these pottery types may be glazed, and the glaze or other decoration is likely to be the most vulnerable characteristic. Some early glazes (e.g., majolica glaze) and glazes on "whiteware" (refined earthenware common at 19th and 20th century sites) may crackle or spall even in a low temperature fire.

Fire Effects on Organic Materials

Organics usually burn or alter at lower temperatures than inorganic items. Artifacts (e.g., basketry, digging sticks, clothing, textiles) and features (e.g., structures, bow-stave trees, wikiups, dendroglyphs) made of or containing organics such as wood, leather, hide, or cordage would require protection or treatment before allowing a fire to burn through a site containing such items. Bone and shell can sustain some degree of burning without complete destruction (Buenger 2003). Many historic structural elements are constructed of building materials that are highly flammable and severely affected by even low temperature fires.

Fire Effects on Inorganic Architectural Materials

Fire damages architectural stone. Above about 572 °F, sandstone begins to oxidize, and at higher temperatures (1,292 °F), it spalls and fractures. These effects can significantly alter features constructed of this material and may constitute a significant effect to sites with these features (Buenger 2003).

Adobe bricks and mortar and rammed earth walls are created from non-flammable sand, silt, and clay. These materials are sometimes mixed with straw, however, and adobe structures are often constructed with wooden poles and posts, which may burn. Walls may be smoothed with adobe plaster. When intact, an adobe structure resists fire. Plaster that is made with gypsum spalls when exposed to sufficient heat, which may expose the more flammable parts of a structure. If the straw used in the adobe burns, the structure may also be weakened (Haecker n.d.). Sometimes roofing and flooring of adobe structures incorporate organic materials, although tile may be used. Mastic sealants may be weakened by fire.

Cement-mortared fieldstone, firebrick, cinder block, and cement aggregate are generally resistant to fire. Low-fired, non-commercial, locally made brick may weaken and crumble in a hot fire. Hot fires also calcinate lime-based mortar, causing it to crumble and eventually causing the wall to collapse. Masonry and cinder block may spall, resulting in damage to the surface of the structure (Haecker n.d.). These materials can also be discolored from soot.

Fire Effects on Rock Art

Fire has a high potential to damage rock art. Though there are no specific temperature guidelines for rock art, fire effects include soot smudging and discoloration from smoke, which obscure the rock art images; degradation of the rock surface from spalling, exfoliation, and increased weathering; changes in organic paints due to heat; and damage to rock varnish, which may destroy its potential to date the art (Tratebas 2004, Kelly and McCarthy 2001 *cited in* Winthrop 2004).

Effects of Fire Suppression on Cultural Resources and Archaeological Sites

Fire suppression activities have a considerable potential to damage archaeological and historic sites. Effects to cultural materials can occur from many activities, including fireline construction (hand line and bulldozer line), establishment of helicopter bases and fire camps, and related activities. Application of fire retardant and other chemical products has the potential to affect cultural resources, although use of fire retardants on historic structures may protect them from destruction during a fire. Cultural resource specialists might need to consider the effects of fire itself versus the effects of retardant use or the possibility of other protection options during a fire. Foam-lines or wetlines would not

affect cultural resources in general, however they might affect Native American traditional plant gathering areas. Fire camps and staging areas in or near known or unidentified archaeological or historic sites may subject the associated surface artifacts to removal or displacement.

Other Effects of Fire

Fire use increases visibility of cultural sites as a result of vegetation burn-off, and consequently increases the potential for vandalism. Fire can cause physical damage to sites from snags/trees falling on them, and can indirectly lead to loss of archaeological data due to increased damage from rain, changes in drainage patterns, soil erosion, and flooding after a fire. Field procedures for identifying cultural sites for protection and avoidance from fire-related activities (e.g., flagging site perimeters, etc.) attract local illegal artifact collectors to vulnerable site localities.

Effects of Mechanical and Manual Treatments

Approximately 2.2 million acres would be treated annually using mechanical methods. Chaining, root plowing, tilling and drill seeding, mowing, roller chopping and cutting, blading, grubbing, and feller-bunching would damage surface and subsurface cultural resources if the sites were not avoided. Treatments involving surface and shallow subsurface disturbance would likely introduce organic materials to lower soil layers, thereby contaminating surface or shallow subsurface cultural resource sites containing early historic or prehistoric datable organics, such as charcoal, wood, or preserved plant materials. Plant and pollen contamination would lead to incorrect or inaccurate analytical results by researchers studying such remains preserved at sites. Surface and shallow subsurface effects would also include horizontal and vertical displacement of the upper portion of soils in which archaeological resources are contained, compromising depositional context and integrity, and artifact damage or destruction.

During treatments, the BLM would have limited ability to avoid plants identified by Native peoples as being important in traditional subsistence, religious, or other cultural practices. Timing of treatments would be critical to avoid conflict with traditional cultural practices. Once concerns of Native peoples were identified, the BLM would take these concerns into consideration when treating vegetation in sensitive areas.

About 270,000 acres would be treated using manual methods. The use of hand tools and hand-operated power tools to cut or clear vegetation could disturb both surface and subsurface cultural resources. However, such manual treatments have the least potential to affect known identified cultural sites. Although dating sample cleaning and processing has improved over the past few years, mulching with organic materials would complicate radiometric dating of materials from cultural resource sites.

Effects of Biological Treatments

Biological treatments using grazing animals could damage surface artifacts and disrupt surface and shallow subsurface cultural materials. However, pretreatment site-specific investigations and development of measures to discourage livestock from using sensitive areas would decrease this possibility. Because of their small size and host-specific action, insects or pathogens would be unlikely to affect cultural resources, although organic site constituents (e.g., baskets, cordage, etc.) might be affected, if present.

Consultation with Indian tribes would be undertaken to locate any areas of vegetation of significance to tribes and that could be affected by biological treatments. The BLM would work with tribes to minimize effects to these resources from grazing or other biological treatments.

Effects of Chemical Treatments

Paleontological Resources

The effect of herbicide treatments on fossil material would vary with respect to: 1) fossil type, 2) minerals, 3) degree of fossilization, 4) whether the fossil was exposed or buried, and 5) method of herbicide application. Although chemicals found in herbicides could possibly affect unique fossil material, herbicide treatments would be more likely to affect researchers, students, or other field personnel conducting paleontological research than the paleontological resources. The most likely cause of damage to fossil materials would be the use of wheeled equipment to apply herbicides. Vehicles driving cross-country would potentially crush fossil material exposed on the surface. Erosion channels or fractured soil crusts that increase or accelerate erosive action may also result from such off-road vehicle use.

Cultural Resources

While herbicide treatments could affect buried organic cultural resources, they would be more likely to have a negative effect on traditional cultural practices of gathering plant foods or materials important to local tribes or groups. The effect of herbicide treatments on cultural resources would depend on the method of herbicide application and the herbicide type used. Some chemicals can cause soil acidity to increase, which would result in deterioration of artifacts—even some types of stone from which artifacts are made. Chemical treatments could also alter or obscure the surfaces of standing wall masonry structures, pictograph or petroglyph panels, and organic materials. While chemicals could affect the surface of exposed artifacts, they could also generally be removed without damage if the artifacts were treated soon after exposure. Organic substances used as inactive ingredients in herbicide formulations, such as diesel fuel or kerosene, could contaminate the surface soil and seep into the subsurface portions of a site. These organic substances could interfere with the radiocarbon or Carbon 14 (C-14) dating of site, and could be opposed by tribes for use near burials (USDI BLM 1991a).

Depending on the selected application method, herbicide applications would have limited ability to avoid plants identified by Native peoples as being important in traditional subsistence, religious, or other cultural practices. Consultation would be undertaken with tribes to locate any areas of vegetation of importance to the tribe that could be affected by herbicide treatments, which could then be subject to potential cancellation. Certain herbicides could also pose a possible health risk, through residues left on plants used as traditional foods or for ceremonial purposes, or by contaminating other food sources or drinking water, as discussed below. A study to assess the exposure of basketweavers to forestry herbicides showed that detectable residues of herbicides were found on 49% of plant materials used by Native Americans inside treatment areas, but only 3% outside of treatment areas, and that residues continued to be detected for several months (Segawa et al. 1997). Tribal basketweavers that gather wild vegetation often place plant parts into their mouths for processing (e.g., cutting, splitting, softening). However, a study of herbicide uptake by lomatium and bitteroot roots in rangeland treated with picloram and sulfometuron methyl showed that no herbicide residues were found in roots at 2, 6, and 45 weeks after treatment (ENSR 2001). Often tribally-gathered root crops occur on lithosols with little soil development and low forage value, such that vegetation treatments may rarely co-occur where traditional gathering takes place. Thus, risks would vary depending on the time of plant use and herbicide treatment, and the portions of the plants that are used.

Herbicide Effects on Native American Health

Exposure Characterization. The potential risks to Native Americans from exposure to herbicides used in BLM programs were evaluated separately from risks to other public receptors (see Human Health and Safety section in this chapter). Native Americans could be exposed to herbicides as a result of subsistence and cultural activities such as plant gathering and consumption of fish caught in local streams; therefore, risk levels determined for Native American receptors reflect unique exposure scenarios as well as typical scenarios for public receptors, but with higher levels of exposure than general public receptors.

Risk Characterization. Native American adults face the same risks that public receptors face, as well as some additional risks as a result of unique subsistence practices or increased time spent in treated areas. Native American adults face health risks from the following scenarios: exposure to diquat when accidentally spilled or applied at the maximum rate (low risk), and consumption of fish contaminated with 2,4-D (high risk), hexazinone (moderate to high risk), or picloram (low risk). Native American children face health risks under scenarios where diquat is applied at the typical rate or fluridone is accidentally spilled; as well as risk from berry picking in an area sprayed with diquat at the typical rate. Native Americans eat far more fish than the general population, and could be exposed to or to ingest fish impacted by herbicide applications. Traditional cultural practitioners, usually elders with greater health vulnerability, may use roadside access where herbicidal treatments have been applied, and may ingest chemicals that have been directly or indirectly (e.g., wind drift) applied to cultural plants.

Beneficial Effects of Treatments

The BLM proposes to treat up to 6 million acres annually. Although these treatments could have adverse effects on paleontological, archaeological, cultural, and traditional use resources and Native American health, effects should be short term, with the exception of loss or destruction of these resources and effects to health. In contrast, restoring natural fire regimes and native

ecosystems would have long-term benefits to these resources and traditional lifeways. Many of these benefits are described in more detail in Appendixes D (Native American Resource Use) and E (Cultural Resources) of the PER.

Protection of Paleontological, Archaeological, and Cultural Resources

Efforts to reduce fire risk through the use of prescribed fire and other treatment methods should ensure the long-term protection of these resources and improve ecosystem health to benefit the plants and animals upon which Native peoples depend. Stabilization and restoration of riparian systems would reduce streambank erosion and ensure that cultural and paleontological resources buried near streams remained intact. Surveys would be conducted to identify the locations of cultural and traditional lifeway resource values prior to treatment activities to ensure that these resources would be protected.

Protection and Enhancement of Vegetation Used by Native Peoples

Although universally important, plant use by Native peoples is extremely varied, both by region and by group. Subsistence use of such plant products as roots and tubers, stalks, leaves, berries, and nuts is essential to Native peoples. Vegetation also provides habitat for fish and wildlife used by Native peoples.

Although modern materials may now replace materials traditionally used by Native Americans, a variety of residential shelters and other buildings, such as ceremonial lodges and sweat houses, may be constructed using a combination of traditional materials and typically employing a locally derived or imported hardwood as part of the structural frame. The frame may then be covered with other materials, such as planks, mats, brush, hides, and other materials that are available. Wood is burned to cook food, smoke cure game and fish, warm dwellings, and facilitate making of native arts, such as ceramics and tools. Trees are often fashioned into various types of watercraft, ceremonial objects, and other structural or non-structural uses. In many cases, an emphasis may be placed on using native and traditional materials for a variety of purposes to perpetuate native arts from generation to generation.

The use of plants for medicinal purposes is widespread. Plants such as tobacco, sweet grass, cedar, and sage, have seen important religious and other ceremonial uses. The use of grasses and other plant resources for basket, box, and tool making also can be observed in the cultures of numerous Native American and Alaska Native groups (Zimmerman and Molyneaux 1996, Bol 1998). Plant products also have been used to make textiles, cordage, and matting, as well as to tan hides. The use of plant dyes, paints, and soaps is widespread.

The BLM's highest priority is to use vegetation treatments to restore high priority subbasins within key watersheds to benefit wetland and riparian vegetation, as well as fish and other aquatic organisms. Over the short term, adverse effects to aquatic organisms from vegetation treatment activities proposed by the BLM would occur, but treatments would lead to improved conditions for aquatic species over the long term. The eventual growth of desirable vegetation in treated areas would moderate water temperatures, buffer the input of sediment and herbicides from runoff, promote bank stability, and contribute woody debris to aquatic bodies. Ongoing efforts by the BLM to enhance riparian vegetation would also help to increase the number of miles of BLM-administered streams that are classified as "Proper Functioning," and provide good habitat for anadromous and other fish that are harvested by Native peoples.

Treatments that remove hazardous fuels from public lands would be expected to benefit the health of plant and animal communities in which natural fire cycles have been altered, and to improve accessibility for tribal cultural practices. The suppression of fire results in the buildup of dead plant materials (e.g., litter and dead woody materials), and often increases the density of flammable living fuels on a site (e.g., dead branches on living shrubs or live plants, especially during dry periods). The resultant fires burn hotter, spread more quickly, and consume more plant materials than fires that historically occurred under conditions of lower fuel loading.

Changes in vegetation composition, distribution, and structure can affect the habitats of fish and wildlife. Fire is an important element in habitat condition. Fire improves the palatability and nutritional value of forbs, grasses, and some shrubs. Fire can improve or enhance wild plant stands used for tribal basketry, such as beargrass, as the new regrowth is more pliable and more abundant. Fire suppression and change in fire regimes due to exotic plant invasions have reduced the quality and availability of many game habitats (Lyon et al. 1995; USDA Forest Service and USDI BLM 2000b).

Treatments that restore and maintain fire-adapted ecosystems, through the appropriate use of mechanical

thinning, fire use, and other vegetation treatment methods, would decrease the effects of future wildfires on communities and improve ecosystem resilience and sustainability. Treatments should also reduce the incidence and severity of wildfires across the West. Treatments that provide a mosaic of forbs, grasses, and shrubs, and reduce stand density in forests should benefit game species such as grouse, deer, and elk and many of the plant species used for traditional lifeway values.

Treatments that control populations of non-native species on public lands would be expected to aid in the reestablishment of native plant species. The use of fire, herbicides, or other treatment methods to simply kill vegetation is often inadequate, especially for large infestations. Thus, the BLM would introduce and establish competitive plants to successfully manage weed infestations and restore desirable plant communities (Jacobs et al. 1999). Treatments to control non-native species would benefit game species and plants used for traditional lifeway values, including species associated with shrubland habitats (e.g., greater sage-grouse, sharp-tailed grouse, quail), where most treatments would occur.

Use of herbicides would enhance the control of weeds and poisonous plants that adversely affect humans, especially weeds most effectively controlled by the four newly proposed herbicides. Herbicide treatments are especially effective in areas where there is insufficient fuel to carry a fire, or where the adverse effects of fire (e.g., erosion, loss of life and property) could be substantial, and where mechanical and other treatments would not be effective due to cost or location. Weeds and other invasive vegetation can displace native species that may be desirable to Native peoples, and may provide poorer quality forage and cover for wildlife used by Native peoples. Consultation between the BLM and affected tribes prior to treatment implementation should ensure that resources important to tribes are protected.

Three of the four new herbicides proposed in the PEIS (diflufenzopyr+dicamba [Overdrive®], diquat, fluridone, and imazapic) pose little risk to Native Americans and other human receptors. Of the 20 previously-approved herbicides, only four (clopyralid, imazapyr, metsulfuron methyl, and sulfometuron methyl) have negligible to low risks to humans. If available for use, the risk to humans per each herbicide application would be lower than under current treatment programs.

Visual Resources

Visual resources consist of land, water, vegetation, wildlife, and other natural or man-made features visible on public lands. Vast areas of grassland, shrubland, and mountain ranges on public lands provide scenic views. In addition, highways, rivers, and trails pass through a variety of characteristic landscapes where natural attractions can be seen and where cultural modifications exist.

For the purpose of planning management activities, public lands are assigned VRM classes according to scenic quality, sensitivity level, and distance zone criteria. Scenic quality, a measure of the visual appeal of the land, is rated based on landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. Sensitivity levels, which are measures of public concern for scenic quality, consider the types of users of the area, the amount of use, public interest in the area, adjacent land uses, and whether the area is classified as a special area. Distance zone criteria are based on relative visibility of the area from treatment routes or observation points. The VRM classes assist in minimizing and/or mitigating adverse effects of land management activities on scenic values (USDI BLM 1986a).

The proposed vegetation treatments would affect visual resources by changing the scenic quality of the landscape. Vegetation treatments would kill or harm vegetation in the applied area, resulting in a more open, "browned" or "blackened" landscape until new plants were to grow in the area. Treatment areas would vary in terms of their visual appeal prior to treatment and their distance from human activity, as well as the resulting public sensitivity to the pre- and post-treatment visual character of the area. Effects on visual resources would be of substantial concern if they 1) reduced the visual rating of the treatment site over the long term, or 2) resulted in short- or long-term degradation of high-sensitivity visual resources. The effects of vegetation treatments on the visual quality of the landscape would be most notable to public land visitors, sightseers, and residents for the first year to several years following treatment, particularly in affected areas found near major roads, residential areas, or recreation areas.

Scoping Comments and Other Issues Evaluated in Assessment

Scoping comments stressed that treatments should improve management of public lands for multiple use

and maximum public benefit. The visual quality of the landscape is seen as one component of public benefit, particularly if lands are located in highly visible areas along roads.

Resource Program Goals

The BLM identifies and evaluates visual resource values through the VRM Inventory system (Handbook H-8410-1; BLM 1986a). The VRM system is a basic tool used by the BLM to inventory and manage visual resources on public land based on VRM classes describing scenic quality, sensitivity level, and distance zone criteria. Visual resource management objectives are established in resource management plans in conformance with land-use allocations (USDI BLM 1984c). These area-specific objectives provide the standards for planning, designing, and evaluating future management projects.

A Contrast Rating System (BLM Manual Handbook H-8431-1; *Visual Resource Contrast Rating*; USDI BLM 1986b) provides a systematic means to evaluate the approved VRM objectives, as well as to identify mitigation measures to minimize adverse visual effects. The Contrast Rating System is designed to compare the respective features of an existing landscape and a proposed project and to identify those parts that are not in harmony. These features include the basic design elements of form, line, color, and texture that characterize the landscape and the surrounding environment. Modifications to a landscape that repeat the natural landscape's basic elements are said to be in harmony with their surroundings, while those that differ markedly may be visually displeasing. The information generated is used as a guide for field managers to decide on the amount of visual change that is acceptable and to minimize potential visual effects. An evaluation should be made of what aspects of the current landscape are "natural," given the significant changes in vegetation caused by fire occurrences that are outside of normal fire regimes. Reference should be made to the fire regime condition classes when evaluating landscape qualities, as the classes help to assess the departure of landscapes from historical fire regimes.

The most dramatic effects would be seen in states and ecoregions with large total acreage treated, such as Nevada, Idaho, and Oregon, and in areas where fire or herbicides were used. Projects with the largest treatment acreage (those over 1,000 acres in size; 20% of all herbicide treatments) would be located in Idaho (22% of large-scale treatments), Wyoming/Nebraska (18%) and Oregon/Washington (16%). Although these states account for 56% of all large-scale treatments, only about 18% of public visitor days on public lands are associated with these states, suggesting that public exposure to treated areas would be less than expected based on size of treatment area and number of acres treated (USDI BLM 2006d). Fire use and herbicide treatments would comprise nearly 65% of these large-scale treatments. Treatments in drier states, such as New Mexico, Nevada, and Wyoming, could have fewer visual effects than comparable treatments in other states because visual color contrast between natural and browned or blackened treated areas would be less dramatic (versus wetter states with higher percentages of green vegetation, especially coniferous forests).

Standard Operating Procedures

There are several SOPs that would help reduce the effects of treatments on visual resources. The BLM would minimize the use of fire and broadcast foliar applications in sensitive watersheds to avoid creating large areas of blackened or browned vegetation. Similarly, the BLM would consider the surrounding land use before assigning fire or aerial spraying as a treatment method, and would avoid fire use and aerial spraying near agricultural or densely populated areas, where feasible. This would serve to reduce the visual effects of large treatments and resulting landscape changes, since treatments would be unlikely to be near areas of high visibility. Furthermore, at areas such as visual overlooks, the BLM would leave sufficient vegetation in place, where possible, to screen views of vegetation treatments. In addition, SOPs for minimizing off-site drift and mobility of herbicides (e.g., do not treat when winds exceed 10 mph; avoid treating areas where herbicide runoff is likely; establish appropriate buffer widths between treatment areas and residences) would also serve to contain the visual changes to the intended treatment area.

During mechanical and manual treatments, the BLM would minimize dust drift, especially near recreational or other public-use areas, and would minimize loss of desirable vegetation near high public use areas. Earthwork would be minimized and located away from prominent topographic features, and sites would be revegetated after mechanical treatments.

In Class I or II visual resource areas, the BLM would ensure that changes to the characteristic landscape were minor and would not attract attention (Class I), or if seen, would not attract the attention of the casual viewer

(Class II). Visual effects could be lessened by: 1) designing projects to blend in with topographic forms; 2) leaving some low-growing trees or planting some low-growing tree seedlings adjacent to the treatment area to screen short-term effects; 3) revegetating the site following treatment; 4) designing structures that fit in with the landscape; 5) minimizing ROW crossings; and 6) selecting colors that blend in with the land, and not the sky. When restoring treated areas, the BLM would design activities to repeat the form, line, color, and texture of the natural landscape character to meet established VRM objectives. A more detailed list of SOPs is found in BLM Manual Handbook H-8431-1 (*Visual Resource Contrast Rating*). All treatments should be evaluated with recognition that the most negative visual aspects would be short term. In the long term, treatments should increase plant species diversity and enhance visual characteristics of the landscape. The potential for extremely negative visual effects by wildfire should be weighed against short-term negative effects from vegetation treatments.

Adverse Effects of Treatments

The removal of vegetation would affect the visual qualities of treatment sites by creating openings and other vegetation-free areas that provide a noticeable visual contrast to the surrounding areas. The degree of these effects would depend on the amount of area treated, the appearance of the background vegetation and the vegetation being removed, the type of treatment method used, and the season of treatment. In general, treatments would have short-term negative effects and long-term positive effects on visual resources.

The greater the area of vegetation removal, the greater the resultant visual effect. Large treatments alter a larger portion of the landscape than small treatments, and the effects are more likely to be observed by people. However, the areas receiving large-scale treatments are most likely to be degraded lands of low to moderate scenic quality, minimizing the extent of these effects. Color contrasts caused by vegetation removal would be most apparent in areas dominated by green vegetation and large plants, such as coniferous forests. The contrast between a cleared area and the surrounding vegetation would be much less for much of the arid west, where low-growing shrubs, and browns, grays, and earth tones dominate the landscape. Exposed soil would not be as apparent. In addition, the brown colors associated with vegetation treatments would be the least noticeable during the late fall and the winter, when they would blend more naturally with surrounding colors than in the spring and summer, when the green colors of new growth are more likely to be present.

Effects of Fire Treatments

During fire treatments, there would be some effects to visual resources, with localized deterioration of air quality and reduced visibility caused by smoke. These effects would only persist as long as the fire itself. Prior to the 1930s, smoke was a common feature of the western landscape in summer (Barrett and Arno 1982). Since then, land managers have focused on controlling wildfires, and smoke has become increasingly viewed by the public and policymakers as undesirable and often avoidable (Schaaf 1994). In addition to affecting the visual characteristics of an area, smoke can also affect the health of humans, plants, and animals that come into contact with smoke.

Following a fire, the blackened appearance of the treated areas would create a color contrast, affecting visual resources. Darkened stumps and snags would be visible for many years following treatments. Although vegetation would begin to reappear in the growing season after the fire, softening the visual contrasts, there would be lasting evidence of the burn.

The total volume of smoke produced from a fire primarily depends on the amount of fuel consumed and the temperature of the burn. Factors influencing smoke production include fuel type, behavior, and moisture; fuel weight per unit area; and particle size and arrangement (see Air Quality section and Tables 4-1 and 4-2). Particulate matter is the most important air pollutant emitted from fire because of its far-reaching effects.

The quantity of emissions from wildfires, and thus the air quality effects from smoke, varies from fire to fire, depending on several factors. A fire's size, duration, intensity, fuel type, surface fuel loading by size class, and fuel moisture content all affect its total fuel consumption and emission characteristics. The fire's intensity and distance from receptors, as well as current meteorological conditions such as wind speed and atmospheric stability, affect the concentrations that arrive at downwind receptors. Regionally, visibility effects are roughly proportional to the total annual emissions from wildfires. The greater the emissions, the greater the expected effects on visibility.

Prescribed fire emissions can be reduced by 1) having clear smoke management objectives, 2) burning when conditions favor rapid combustion and dispersion, 3)

burning under favorable moisture conditions, 4) using backfires when applicable, 5) burning smaller vegetation blocks when appropriate, and 6) coordinating with regional and local air pollution and fire control officials to ensure that the burn plan complies with federal, state, and local regulations.

Effects of Mechanical Treatments

Use of mechanical treatments to clear vegetation would be likely to remove large quantities of vegetation from a treatment site, in many cases exposing soil and leaving dead plant material on the ground to turn brown. Mechanical methods such as tilling, mowing, and chaining have the potential to scarify the landscape and leave bare soil and dead vegetation that contrast with the surrounding colors (BPA 2000). Mowing can also create an uneven, ragged appearance along roadsides and ROWs, but in other areas can result in a well-manicured, pleasing look.

Mechanical treatments on flat terrain, such as sagebrush communities, would have less effect on visual resources than treatments on steeper terrain, such as pinyon-juniper woodlands, which would be more visible on the landscape. The effects of mechanical treatments on visual resources would be temporary, and would only last until the reestablishment of vegetation on the treatment site, typically one or two growing seasons.

Effects of Manual Treatments

There would be some visual changes to the landscape as a result of manual treatments, but since this treatment method would be limited to small areas, these changes would be much less noticeable than the alterations caused by other treatment methods. In some cases, manual treatments would result in the extraction of weeds from a sensitive site, immediately resulting in an improvement in the quality of visual resources on the site. In other cases, such as the removal of vegetation with chainsaws, the effects would be negative, though minor, and would last until the treated areas were concealed through revegetation.

Effects of Biological Treatments

Containment by Domestic Animals

The use of domestic animals to contain undesirable vegetation would cause minimal effects to visual resources. The sight of domestic animals should not cause any adverse effects, as the presence of these animals is typically common and expected on public lands. Trampling and consumption of vegetation by livestock, as well as the presence of feces on the ground, would minimally reduce the quality of visual resources. However, these effects of grazing would not create sharp visual contrasts, and would be short term in nature, becoming largely unnoticeable after revegetation of the site.

Other Biological Control Agents

The use of insects and pathogens to control weeds would cause some visual alterations to the landscape. Plants attacked by these agents often show visual symptoms of disease or parasitism are regarded as visually unappealing. However, these changes would only be noticeable upon close examination of the site. The overall appearance of the treatment area would likely remain relatively unchanged. Because these agents kill target species gradually, the effects would be less visibly distinct than treatments that kill a large area of vegetation all at once.

Effects of Chemical Treatments

In general, herbicide treatments would have short-term negative effects and long-term positive effects on visual resources. The greater the area of vegetation treatment, the greater the visual effect is likely to be. Large treatments alter a larger portion of the landscape than small treatments, and the effects are more likely to be observed by people. However, areas receiving large-scale treatments are most likely to be degraded lands of low to moderate scenic quality, resulting in a smaller visual effect from treatment and likely an improvement in the scenic quality of the land over the long term. Color contrasts caused by vegetation removal would be most apparent in areas dominated by green and/or flowery vegetation and by large plants, such as coniferous forests. The visual effects would be heightened if the herbicides also prevented the manifestation of seasonal changes in vegetation, such as spring flowers and/or fall color. The contrast between a cleared area and the surrounding vegetation would be less for much of the arid west, where low-growing shrubs, and browns, grays, and earth tones dominate the landscape, than for areas with greater amounts of rainfall (e.g., Marine Ecoregion). Therefore, browned vegetation would not be as apparent. In addition, the brown colors associated with vegetation treatments would be the least noticeable during the late fall and the winter, when they would blend more naturally with surrounding colors than in the spring and summer, when the green colors of new growth are more likely to be present.

For all treatment methods, effects to visual resources would begin to disappear within one to two growing seasons after treatment in most landscapes. The regrowth of vegetation on the site would eliminate much of the stark appearance of a cleared area. Effects would last for the longest amount of time in forests and other areas where large trees and shrubs were removed.

Beneficial Effects of Treatments

The BLM proposes to treat 6 million acres annually. Thus, adverse and beneficial effects to visual resources should be about 3 times greater than current treatment effects. For all treatment methods, effects to visual resources would begin to disappear within one to two growing seasons after treatment. The regrowth of vegetation on the site would eliminate much of the stark appearance of a cleared area, and the area would develop a more natural appearance. Effects would last for the longest amount of time in forests and other areas where large trees and shrubs were removed.

Over the long term, vegetation treatments would likely improve visual resources on public lands. Treatments that aim to rehabilitate degraded ecosystems, if successful, would result in plant communities that are dominated by native species. Native-dominated communities tend to be more visually appealing than areas that have been overtaken by weeds (e.g., areas supporting a downy brome monoculture), or that have been invaded by woody species (e.g., grasslands experiencing encroachment by conifer seedlings). These improvements would be most evident in the Temperate Desert Ecoregion, where over half of all large-scale treatments would occur.

Fire use and other treatment methods that restore native fire regimes, vegetation, and ecosystem processes would reduce the spread of noxious weeds and other invasive vegetation that is less visually appealing than native vegetation. Catastrophic wildfires, which can affect thousands of acres, often occur in the WUI, or in close proximity to campgrounds and other recreational use areas, where their effects are visible to the public. In high visitor use areas or the WUI, non-fire treatments can be used to avoid the visual effects associated with smoke and to integrate treated and untreated areas into a more visually appealing mosaic of vegetation types.

The use of fire would allow the BLM to limit the size and duration of fires in areas of high public use to minimize visual contrasts between burned and unburned vegetation and effects of smoke. As discussed under Air Quality, an analysis of a vegetation management program in the Interior Columbia Basin showed that wildfire effects on air quality and visibility could be significantly greater in magnitude than effects from prescribed burning. Thus, vegetation treatment actions that improve ecosystem health and reduce hazardous fuels buildup, thereby reducing the risk of wildfire, should provide short- and long-term benefits to local and regional air quality.

The controlled use of domestic animals to contain undesirable vegetation may create a short-term visual impact associated with trampling and consumption of vegetation. These impacts would be dealt with on a case by case basis and mitigated as appropriate at the project level. The visual effects of containment by domestic animals would be short term in nature and would create a positive visual effect with the regrowth of desirable vegetation in a healthy, productive condition.

In general, herbicide treatments would have short-term negative effects and long-term positive effects on visual resources. The greater the area of vegetation treatment, the greater the visual effect is likely to be. Large treatments alter a larger portion of the landscape, and the effects are more likely to be observed by people. However, areas receiving large-scale treatments are most likely to be degraded lands of low to moderate scenic quality, where visual effects would be minimal and treatments would likely improve the scenic quality of the land over the long term. Color contrasts caused by vegetation removal would be most apparent in areas dominated by green and/or flowery vegetation and by large plants, such as coniferous forests. The visual effects would be heightened if the herbicides prevented the manifestation of seasonal changes in vegetation, such as spring flowers and/or fall color.

Wilderness and Special Areas

The invasion of noxious weeds and nonnative plant species into wilderness ecosystems and their effects on wilderness naturalness is of great concern to resource managers and the public. The presence of nonnative and nonindigenous species is significantly increasing in wilderness. Some species have been introduced to wilderness areas through pack stock feces, or by wild horses and burros that may migrate in and out of wilderness areas (Hendee and Dawson 2002). Hikers and wildlife may also bring in weed seeds on their clothing, fur, or droppings. In addition, efforts to control and remove invasive species can sometimes cause

additional changes beyond restoring the preexisting "natural" conditions.

Because of their special status, wilderness and special areas have strict guidelines for vegetation treatments. These guidelines prohibit activities that degrade the quality, character, and integrity of these protected lands. Vegetation treatments used in wilderness areas follow the guidance contained in the BLM's *Interim Management Policy* (USDI BLM 1995) and the *Management of Designated Wilderness Areas* (USDI BLM 1988d). The guidance states:

- Prescribed burning would be used where necessary to maintain fire-dependent natural ecosystems.
- Noxious weeds may be controlled by grubbing or with chemicals when they threaten lands outside wilderness or are spreading within the wilderness, provided the control can be effected without serious impacts on wilderness values.
- Reseeding would be done by hand or aerial methods to restore natural vegetation.

There are no set restrictions on vegetation treatments in other types of special areas. However, the unique characteristics of these areas would be considered when preparing plans for treatment activities.

Scoping Comments and Other Issues Evaluated in Assessment

Respondents suggested that weeds should be stopped from spreading into wilderness areas by treating them outside of these areas, while others requested that treatments within wilderness areas be undertaken only after the spread of weeds outside of these areas has been effectively halted. Other respondents proposed that unique natural areas, including riparian zones, roadless areas, old growth areas, and areas of highest biological integrity, should be protected and that roadless areas should not be treated.

Resource Program Goals

The Wilderness Act of 1964 gave the Forest Service, National Park Service, and USFWS the authority to study, protect, and manage "legal" wilderness on lands under their jurisdiction; the Act failed to give the BLM comparable authority, even though the agency managed far more land than the other federal agencies (Hendee and Dawson 2002). In 1976, the FLPMA called on the BLM to study and manage legally designated wilderness, and to make recommendations to the president. The ANILCA of 1980 withdrew BLM roadless lands in Alaska from wilderness review, but stated that the Secretary of the Interior, at personal discretion, could periodically study and make wilderness recommendations to Congress. In 1981, the Secretary of the Interior issued a memorandum directing that no further wilderness inventory and review be done in Alaska; this memorandum remains in effect, except for a wilderness review of the Central Arctic Management Area specifically mandated by ANILCA legislation.

The primary activities of the Wilderness Management program are to inventory public lands for wilderness character, prepare activity plans, and monitor and manage wilderness and wilderness study areas. The BLM manages wilderness to provide the American people of present and future generations with the benefits of an enduring resource of wilderness (USDI BLM 2006c). Approximately 86% of wilderness acres administered by the BLM are achieving wilderness character as specified by statute, while about 73% of wilderness study areas are meeting their heritage resource objectives. Management of designated wilderness has included recent efforts to reclaim areas damaged by vehicles in California, and controlling saltcedar in the South Jackson Mountain Wilderness Area in Nevada.

Standard Operating Procedures

Actions that reduce the spread of noxious weeds, prevent the establishment of new invaders, and promote public awareness would be encouraged by the BLM in wilderness and other special areas and would provide long-term benefits to wilderness and other special areas and to the users of these areas. In particular, the BLM would encourage backcountry pack and saddle stock users to feed their livestock only weed-free feed for several days before entering a wilderness area. In addition, stock users would be encouraged to tie and/or hold stock in such a way as to minimize soil disturbance and loss of native vegetation. Disturbed sites would be reseeded with native vegetation, where feasible, to enhance the long-term development of native vegetation. Educational materials would be provided at trailheads and other wilderness entry points to make the public aware of the need to prevent the spread of weeds.

The BLM would use the "minimum tool" to treat noxious and invasive vegetation, relying primarily on use of ground-based tools, including backpack pumps,

hand sprayers, and pumps mounted on pack and saddle stock. If mechanized equipment were used, the BLM would: 1) use the minimum amount of equipment needed; 2) time the work for weekdays or off-season; 3) require shut down of work before evening if work was located near campsites; and 4) if aircraft were used, plan flight paths to minimize disturbance to visitors and wildlife. In general, motorized equipment would only be used for emergency situations involving the health and safety of visitors, for administrative purposes, and in emergency situations involving criminal law. The BLM would give preference to those herbicides that have the least effect on non-target species and on the wilderness environment, and would implement herbicide treatments during periods of low human use, where feasible (USDI BLM 1988d). Other SOPs that would be followed by the BLM include addressing wilderness and special areas in management plans, maintaining adequate buffers for Wild and Scenic Rivers (¼ mile on either side of river; ½ mile in Alaska), and revegetating disturbed sites with native species if there is no reasonable expectation of natural regeneration.

Adverse Effects of Treatments

The overall effect of treatments on wilderness areas and wilderness study areas would depend on whether the end condition of the treatment site (considering both long-term benefits and short-term effects) was an improvement in wilderness characteristics. In many cases (e.g., an eradication of a small population of an incipient pest, a prescribed fire that mimicked historical fire), communities in the treatment area would quickly recover, and the overall effect would be positive. In other cases (e.g., treatments that require the creation of access roads to treatment sites, treatments that require repeated access to a site in order to meet a desired objective), the effects of the treatment to the wilderness character of the site would outweigh the potential long-term benefits.

The short-term effects of vegetation treatments in other special areas would typically be less than those in wilderness areas, as human activities and influences are not necessarily incompatible with their unique qualities. However, all treatments would have the potential to alter these unique qualities, as well as to provide long-term benefits by controlling weeds and reducing fire risks.

Effects of Fire Treatments

Periodic fires are a natural part of most wilderness ecosystems, and the goal of wilderness fire management is to restore fire as nearly as possible to its natural role (Hendee and Dawson 2002). Fire influences the species composition of plant communities, interrupts and alters plant succession, influences the scale of the vegetation mosaic, regulates fuel accumulations, and influences ecosystem productivity, all important factors determining the characteristics of wilderness.

The objectives of fire management in wilderness are to: 1) permit lightning-caused fires to play, as nearly as possible, their natural ecological role within wilderness, and 2) reduce, to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness (USDI BLM 1988d). Fire caused by lightning will be permitted to burn or will be suppressed as prescribed in an approved burn plan. Prescribed fires ignited by people may be permitted to reduce unnatural buildup of fuels only if necessary to meet the above objectives. Although additional benefits may result from man-ignited prescribed fire, vegetative manipulation cannot be used to justify such fires.

Prescribed fire would be used in wilderness areas only as a means to meet the objectives of reducing the risks of wildfires and maintaining fire-dependent natural ecosystems within these areas (USDI BLM 1988d). The ability of a fire treatment to follow these guidelines would depend on a number of factors, including the amount of fuels accumulation and other conditions at the treatment site. Fires that were more intense than historical fires, or that were set more frequently than under historical regimes, would have the potential to alter the ecological characteristics of a wilderness area and endanger human life and property (Hendee and Dawson 2002). In areas where fire exclusion has changed an ecosystem's attributes (ponderosa pine forests, for instance), a well-planned controlled burn would likely benefit wilderness areas.

The effects of fire on other special areas would depend on a number of factors, such as the vegetation type of the site, the condition of the site, and the particular unique quality of the site that requires special management. In general, sites with special qualities that could be destroyed by fire would be the most likely to experience significant adverse effects from fire treatments. Sites at which natural fire cycles have been altered, and that do not contain attributes that would be susceptible to loss by burning, would be likely to benefit from these treatments.

Effects of Mechanical Treatments

Motorized equipment is allowed by the Wilderness Act to meet the minimum administration requirements of a wilderness area, as specified in Section 4(c) of the Act. However, very few activities and situations within wilderness justify or require the use of motorized equipment and/or mechanical transportation. The BLM State Director must approve or disapprove the use of motorized equipment and mechanical transport in writing by letter and a Decision Notice on a one time, case-by-case basis (USDI BLM 1988d). If mechanized equipment was allowed, effort would be made to: 1) use the minimum amount of equipment needed; 2) time the work for weekdays or off-season; 3) require shut down of work before evening if work was located near campsites; and 4) if aircraft were used, plan flight paths to minimize disturbance to visitors and wildlife.

For the most part, use of mechanical treatment methods would adversely affect wilderness areas and wilderness study areas because vehicles and heavy equipment are incompatible with the "unspoiled" nature of wilderness. For this reason, mechanical treatments would only be allowed on a very limited number of sites where no other method is feasible (e.g., tamarisk removal) and in the few areas where mechanical treatments have occurred in the past, and repeat treatments are required. Aerial reseeding would also be allowed to restore natural vegetation. In all of these cases, mechanical treatments would require special approval, and would be carefully planned to improve or maintain the quality of wilderness areas and wilderness study areas.

The effects of mechanical treatments on other special areas would be similar to the effects of fire, as discussed under Effects of Fire above, in that they would be highly dependent on the resources present at the site. In particular, the unique resources requiring special protection would be important factors to consider. Thinning treatments in areas that are managed primarily for recreational purposes, such as National Historic Trails, would not be likely to result in a loss of quality as long as their recreational assets were left intact. However, thinning treatments in forests with old-growth characteristics could have significant adverse effects.

Effects of Manual Treatments

Manual treatments would be the least obtrusive method for use in wilderness areas and the most appropriate. Because this method of vegetation removal is very selective, damage to non-target vegetation would be minimized.

Effects of Biological Treatments

In areas that did not historically support livestock grazing, and where grazing use does not currently occur, the use of domesticated grazing animals to control vegetation in wilderness areas and wilderness study areas would involve the introduction of a non-native domestic animal into these largely unaltered landscapes, thereby potentially introducing new effects. Domesticated grazing animals could alter plant communities, spread noxious weeds on their fur or through their feces, and potentially influence native wildlife movements and use patterns within wilderness areas.

Effects associated with the use of domestic grazing animals have the potential to affect wilderness areas and other types of special areas. However, in many cases, grazing would be compatible with the designated uses of these areas, and the use of grazing animals to control weeds would be less intrusive than other treatments, particularly mechanical methods.

The use of other biological control agents (e.g., insects, pathogens) to control vegetation in wilderness areas and wilderness study areas would involve the introduction of non-native organisms into these largely unaltered landscapes, thereby potentially introducing new effects. However, these other biological control agents would not be likely to adversely affect wilderness areas, wilderness study areas, or any other scenic resources or special areas managed by the BLM, provided that they were host-specific and only affected non-native plant species. Although the risks of its occurrence are slim, an inadvertent release of a biological control agent that affects native species could significantly degrade the ecological integrity of wilderness areas and make wilderness study areas unsuitable for wilderness designations.

Effects of Chemical Treatments

Use of herbicides to treat undesirable vegetation could potentially affect the "naturalness" of wilderness areas and wilderness study areas by killing non-target native vegetation through imprecise application and/or drift. The degree of effect would depend on the application method, with spot applications less likely to cause adverse effects than aerial applications. For the most part, vehicle-mounted sprayers would not be used to treat vegetation, given the existing restrictions on wilderness areas. However, vehicles could be used in extreme scenarios, if approved.

The potential effects of chemical treatments on other special areas would depend on numerous site-specific factors. Some special areas would support resources that are more sensitive to exposure to herbicides than the resources in other areas. There would also be human health risks involved with using certain types of herbicide application (e.g., aerial application) in special areas that are managed to support recreational activities. A more detailed discussion of these risks can be found in the Wilderness and Special Areas and Human Health and Safety sections of Chapter 4 of the PEIS.

Beneficial Effects of Treatments

In general, vegetation treatments in wilderness and special status areas would have short-term negative effects and long-term positive effects on these specially designated areas. In wilderness areas and wilderness study areas, treatments would only be allowed in order to improve the natural condition of these areas. Therefore, if treatments were successful, long-term effects would be beneficial by reducing noxious weed infestations and reducing the risk of future catastrophic wildfires.

The reduction of hazardous fuels and noxious weeds on lands adjacent to or near wilderness and special areas would provide long-term benefits by reducing the likelihood that noxious weeds would spread onto these unique areas, or that a catastrophic wildfire would burn through them, thus degrading their unique qualities. Because there would be fewer restrictions on the intensity of treatments on lands adjacent to wilderness and special areas than on lands in these areas, preventative treatments in areas adjacent lands would eliminate or reduce the need for intrusive treatments in wilderness and special areas in the future. The need for emergency fire suppression activities, which can be very damaging, would also be reduced.

Prescribed fire would be used in wilderness areas only as a means to meet the objectives of reducing the risks of wildfires and maintaining fire-dependent natural ecosystems within these areas (USDI BLM 1988d). Few activities and situations within wilderness and other special areas would justify or require the use of motorized equipment and/or mechanical transportation. Manual treatments would maintain or improve the wilderness qualities of an area without causing effects that are incompatible with established wilderness principles. Other special areas would also benefit from manual treatments, with low risks that their definitive qualities would be degraded. Insects and pathogens used a biological control agents would have minimal effect on wilderness values. The long-term effects of herbicide treatments on wilderness and other special areas would depend on the success of the treatment in controlling noxious weeds. In most cases, the benefits of eradicating noxious weeds from wilderness and other special areas would far outweigh the potential short-term negative effects of using chemical treatments.

Recreation

Approximately 40% of public lands are within a day's drive of 16 major urban areas in the west (USDI BLM 2006c). Outdoor recreation, nature, adventure, and heritage tourism are the fastest growing segments of the travel and tourism industry. In 2003, recreational use of public lands predominantly consisted of camping and picnicking, which represented 43% of all visitor days (USDI BLM 2006d). Other important recreational activities included non-motorized travel, such as hiking, horseback riding, and mountain biking; OHV travel; viewing public land resources, interpretation, and education; and hunting. Snow- and ice-based activities, such as cross-country skiing, snowmobiling, and snowshoeing represented less than 1% of visitor days. The BLM administers many acres of public lands and facilities, in part for these recreational pursuits. Many of these lands are managed for multiple uses, such that activities designed for one program or purpose (e.g., vegetation control/enhancement) must be compatible with other programs and purposes.

Intensively managed, developed recreation areas are near major urban centers in California, Arizona, and Utah. These areas include National Monuments and other National Conservation Areas (see Map 3-12). In recreation areas, the goals of vegetation treatments include maintaining the appearance of the area and protecting visitors from the adverse effects of contact with noxious weeds and other invasive or unwanted species. Treatments would likely be done using mechanical and manual methods, or with spot treatments using herbicides, and treatment effects on the public would be minimal. The likelihood of herbicide treatments would increase with increasing distance away from high-use visitor areas. Thus, hikers, hunters, campers, horsemen, livestock owners, and users of plant resources for cultural, social, and economic purposes would be at the greatest risk of coming into contact with herbicide treatment areas.

Scoping Comments and Other Issues Evaluated in Assessment

Several respondents remarked that treatments should not be used as an excuse to close OHV trails. Another commenter requested that areas not be treated solely to improve recreational use. If any travel or access routes would be closed, the effects on recreation and nearby areas that would handle the shift in use should be addressed. The effects of herbicides on recreational users should also be addressed.

Resource Program Goals

The long-term goal of the BLM's Recreation Management program is to provide opportunities to the public for environmentally responsible recreation. BLM-administered public lands host over 68 million visitors annually, and over 4,000 communities with a combined population of 23 million people are located within 25 miles of public lands. Although much of the focus of the program is on providing visitor services, the BLM's most daunting challenge is to manage travel on public lands. Technological advances in modes of transportation, coupled with the explosion of growth of this activity, have created a management challenge to meet these needs while protecting land resources (USDI BLM 2006c). As pointed out during scoping, the public recognizes the potential for travel access routes to spread weeds and for off-road travel activities to degrade land, leading to conditions that favor the establishment and spread of weeds and other unwanted vegetation.

Standard Operating Procedures

Recreation activities on public lands are guided by BLM Handbook H-1601-1 (*Land Use Planning Handbook, Appendix C*). There are several SOPs that could help reduce the negative effects of herbicide treatments on recreation:

- Schedule treatments to avoid peak recreational use times, where feasible. However, managers must also time treatments when they would be most effective, which may be during peak public visitation periods.
- Notify the public of treatment methods, hazards, times, and nearby alternative recreation areas.
- Adhere to entry restrictions identified on the herbicide label for public and worker access.
- After herbicide treatments, post signs noting exclusion areas and their duration.

In addition, SOPs identified in Table 2-5 and in the Human Health and Safety, Fish and Aquatic Resources, and Wildlife Resources sections should be implemented to further reduce risks to recreationists and the resources they use.

Adverse Effects of Treatments

Effects on recreation activities would likely be greatest in states with the most acres treated (Nevada, Idaho, Oregon, and Wyoming), or in which large-scale treatments are proposed to occur (Idaho, Oregon, Wyoming, and Montana; Table 4-14). However, based on visitor use days, the number of visitors to public lands in these states as a percentage of all visitors to public lands is small in relation to the number of acres treated in those states (USDI BLM 2006d), suggesting that effects to recreationists could be less than expected based on treatment acreage. Treatments that occur in states with a large number of visitors (Arizona, California, and Utah) could have a greater effect on recreationists. Over 85% of large-scale treatments would involve mechanical or chemical treatment methods, or use of fire, each in nearly equal proportion. These are also the methods most likely to have an adverse effect on the landscape and recreationists.

There would be some short-term scenic degradation, as well as distractions to users (e.g., noise from machinery), from treatments. In addition, there would be some human health risks to recreationists associated with exposure to herbicides or smoke from fire. These risks are discussed in more detail in the Human Health and Safety section. Finally, some areas would be off-limits to recreation activities as a result of treatments, for periods ranging from a few hours to days, or even one full growing season or longer, depending on the treatment. In most cases, recreationists would be able to find alternative sites offering the same amenities, although a lessened experience could result from more concentrated use in these alternative sites.

Dispersed recreation in non-developed areas would potentially be affected to a greater degree than recreation in developed sites because most of the 6 million acres of vegetation treatments would occur in these undeveloped, dispersed areas. Recreational activities in these areas are spread out across the

landscape, and different types of recreational activities would be affected differently. For example, hikers or backpackers would likely avoid using an area treated with herbicides, but would probably continue to use a trail passing through a mowed or mulched area. Effects to recreation in areas with an abundance of recreational opportunities (e.g., Alaska) would not be as significant as effects in areas with less extensive recreational opportunities. Recreational use of motorized vehicles on public lands is typically limited to designated routes and trails. Trails located in treatment areas would be closed during treatments and for a period of time following treatments to allow vegetation to recover. Closures could last for several growing seasons following more intensive treatments where vegetation was completely removed, while less intensive treatments might not require site closures beyond what was recommended for safety.

The effects of herbicide treatments and fire use on fish and wildlife could have indirect negative effects on recreational activities such as fishing, hunting, and wildlife viewing. For example, aerial application of an herbicide over a large area could adversely affect these types of recreation activities by harming or displacing game and non-game fish and wildlife species.

Vegetation treatments could also affect scenic views, particularly large treatments next to roads, and smoke-producing fire treatments. The effects of vegetation management on the visual quality of the landscape are discussed further in the Visual Resources section.

Effects of Fire Treatments

Prescribed burns would require the closure of burn areas to visitors during burn activities. People recreating in nearby areas would be able to see and perhaps smell smoke. The potential for smoke inhalation could result in some health risks to these users (see Human Health and Safety), depending on their vicinity and position (i.e., upwind or downwind) in relation to the fire. Because smoke impairs visibility, views of the landscape could be blocked during burning. These effects would reduce the recreation experience, but would typically last only as long as the burn treatment itself. After a fire, the burned area would appear blackened, and some residual vegetation would be charred, making the area undesirable for most recreational uses for a period of 1 or more years. Four-wheel drive vehicles and OHVs could be excluded from areas treated with fire to minimize damage to these sites while they revegetated. Low impact uses such as camping and hiking would generally not be restricted, but it is likely that burned areas would be avoided by users engaging in these types of activities. Visitation to a prescribed burn area would decline drastically or cease altogether in the short term, but would likely increase in the long term as a result of habitat improvement. Some visitors would be attracted to recently-burned areas to view wildflower blooms that often follow wildland fire.

Effects of Mechanical Treatments

Mechanical equipment would primarily be limited to mowers, trenchers, and graders in developed recreational sites, and would have limited effect on recreation activities. In dispersed recreation areas, however, mechanical treatments such as chaining, tilling, and seeding could require the temporary closure of treatment sites to visitors. Low intensity treatments such as thinning would generally be less restrictive to recreational uses than treatments such as chaining or plowing. People recreating in nearby areas would be able to hear the motorized equipment and could be exposed to some exhaust smells, but these effects would last only as long as the treatment itself (BPA 2000). After the completion of treatments, vegetation would be absent from large portions of the landscape and bare soil would be exposed, making the site less desirable for recreation. The use of heavy machinery would disrupt the treatment area, breaking limbs and disturbing soil. It is also likely that some large debris would be left behind, creating obstacles for certain types of uses (BPA 2000). In addition, use of heavy machinery could create routes for unauthorized OHV use in some areas. This activity could interfere with other types of recreation and potentially add to scenic degradation by interfering with recovery of the site and contributing to the spread of weed seeds. Some treatments (e.g., mowing) would improve the visual appearance of a site, making it more pleasurable to visit and increasing its accessibility (e.g., clearing vegetation around a lake for fishing). The removal of woody vegetation could also improve access for some recreational activities, such as authorized use of off-road vehicles. The negative effects of mechanical treatments on recreation could last from a few days to several years or more, depending on how much vegetation was removed and the rate of site recovery (USDI BLM 1991a).

Effects of Manual Treatments

Manual treatments would have few effects on recreationists since they would not occur over extensive areas, cause significant habitat disruption, or require closures of large sites during treatment. The noise associated with power tools such as chainsaws could

TABLE 4-14
Percentage of Vegetation Treatments, Large-scale Vegetation Treatments, and Visitor Use Days for Each State/Region

State	All Treatments (%)[1]	Large-scale Treatments (%)[2]	Visitor Use Days (%)[3]
Alaska	2.4	0.4	1.7
Arizona	4.7	6.4	23.7
California	3.9	1.7	23.7
Colorado	4.1	4.7	5.9
Idaho	15.7	22.2	6.7
Montana, North Dakota, South Dakota	4.6	9.6	4.1
Nevada	30.5	8.2	8.1
New Mexico, Oklahoma, Texas	3.2	6.4	2.5
Oregon, Washington	14.5	15.9	9.0
Utah	5.9	4.3	12.2
Wyoming, Nebraska	10.6	17.8	2.5

[1] Acres treated in each state as a percentage of total acres treated on public lands.
[2] Percentage of large-scale treatments (treatments > 1,000 acres) on public lands in each state.
[3] Visitor use days as a percentage of total visitor use days on public lands.
Source: USDI BLM (2000d).

distract nearby users (BPA 2000). In some instances, the presence of workers could also cause a minor distraction. These effects would be limited in extent and last only as long as the treatments. There would be some visual changes to the landscape as a result of manual treatments, but they would only occur on small areas, and would be much less noticeable than the alterations caused by other treatment methods.

Effects of Biological Treatments

Containment by Domestic Animals

Domestic livestock would generally not be used in developed recreation sites, but are more likely to be used in dispersed recreation areas. There could be some adverse impacts to recreation as a result of biological control using domestic animals. Some recreational activities, particularly more intensive recreational events, may not be able to occur simultaneously with grazing treatments. If it was necessary to concentrate domestic livestock to provide intensive vegetation management, these areas may be off-limits to many recreational activities during grazing treatments, but restrictions would typically be short-term and would not be extensive. In many cases, recreationists would be able to bypass areas using concentrated livestock management and utilize alternative recreation sites. Other negative impacts during and following grazing treatment could include visual effects associated with the appearance of grazed and trampled vegetation and the presence of manure, but these effects would potentially be less noticeable than those associated with other methods that leave more dead, standing, piled, or burned vegetation on the treatment site.

Other Biological Control Agents

The use of biological control agents (e.g., insects and pathogens) would have few effects on recreation areas and visitors to public lands since they would specifically control undesirable species without disturbing desirable vegetation or the land. During the release of biological control agents, there would be some workers present that could cause a minor distraction to recreationists in the area. Death or injury to large numbers of plants could reduce the quality of the recreation experience. These effects would last until undesirable plant populations were reduced to the point where they no longer supported populations of these biological control agents.

Effects of Chemical Treatments

Chemical treatments would affect the availability of recreational opportunities because of site closures, changes to wildlife habitat, loss of edible plants and fruits on the treated site, and possible contamination of vegetation and water bodies off site (USDA Forest Service 1988). Site closures would generally last for a short time period following herbicide application, depending on the recommendations on the herbicide

label. Usually the recommended exclosure periods would not exceed 24 hours; however, recreational access could be restricted for a season or more to allow vegetation to recover following treatment.

During site closures, signs stating the chemical used, the date of application, and a contact number for more information, and would be posted for a period of at least 2 weeks following treatment. Dead brown vegetation would temporarily reduce recreational potential until vegetation recovered. Herbicide treatments could also pose some health risks to recreational users, which would be greatest during aerial herbicide applications and when ingesting contaminated resources, such as berries or fish (see Human Health and Safety section of the PEIS). It is likely that herbicide use would negatively affect sightseeing recreational opportunities. Herbicide treatments would generally result in long-term benefits to recreationists by controlling noxious weeds and toxic plants.

Unintended effects of herbicides on non-target plants and animals could impact recreation activities (e.g., hiking, plant collecting, hunting, and fishing) in off-site areas. The longer an herbicide lingers in soil (depending on its ability to bind to soil [Koskinen et al. 2003]), the more likely it is to contaminate groundwater or run off into water bodies used by recreationists.

Beneficial Effects of Treatments

Treatments that restore native vegetation and natural fire regimes and ecosystem processes would be beneficial to recreationists. Treatments would improve the aesthetic and visual qualities of recreation areas for hikers, bikers, horseback riders, and other public land users; reduce the risk of recreationists coming into contact with noxious weeds and poisonous plants; increase the abundance and quality of plants harvested from public lands; and improve habitat for fish and wildlife sought after by fishermen and hunters.

Developed recreation sites with public facilities would be treated in order to maintain the appearance of the area and to protect visitors from the adverse effects of unwanted vegetation (e.g., thistles, ragweed, and poison ivy). Some mechanical activities, such as mowing in visitor use areas or along ROWs, would provide an immediate benefit in terms of improved appearance of vegetation.

Recreationists in these dispersed recreation areas would likely benefit from a reduction in invasive plants (especially thorny or poisonous noxious weeds) provided by vegetation treatments. Removal of weedy vegetation would return public lands to a more “natural” or desirable condition, which hikers and nature enthusiasts would likely value over that of degraded lands. In addition, the increased aesthetic value of treated sites would benefit most recreational users. In some instances, treated sites could become more desirable as destinations for outdoor activities, making them more popular to recreational users. Treatment of sites to restore native vegetation would enhance fish and wildlife habitat, to the benefit of hunters, birdwatchers, and other users of these resources.

Fuels reduction treatments would reduce the severity of future wildfires on public lands used for recreation. As a result, recreationists would be provided with safer conditions, and there would be less of a chance that a wildfire would destroy a large acreage of lands used for recreation. Severe wildfires are capable of causing damage to recreational resources over large areas that subsequently require long periods of time for recovery. In addition, treatments that reduce the risk of wildfire would reduce the likelihood of recreationists being displaced from their favorite hunting, fishing, and camping sites by wildfires. During the recent wildfires that swept through the Great Basin, not only were traditional recreation activities affected, but some special events were altered or cancelled. Signs were destroyed, hiking and camping areas burned over, wildlife and game displaced, and the scenery in the Great Basin marred (USDI BLM 1999).

Social and Economic Values

Vegetation treatments have the potential to affect people, communities, and economies in each of the 17 western states that could receive treatments. The susceptibility of these entities to social and economic effects stems from the importance of public lands to the lives of the people and communities in the West, especially in the states with the largest amounts of public land, either in total area or in percentage of the state. Public lands commonly provide a major portion of economic sustenance, especially in rural areas, by supporting ranching (grazing leases), mining, active and passive recreation opportunities, and a myriad of other activities that westerners rely on. The dollar value of the social sustenance may not be readily quantifiable, but it is important to the way of life of westerners. “Wide open spaces” are not just a cliché in western songs and novels, but a tangible part of the experience that attracts and/or retains people who live in western states. The large expanses of federal lands are a significant

contributor to the open spaces that define the "sense of place" in many parts of the West. Through support of economies and the social context of the West, federal lands are highly important to the western states. Actions that affect federal lands, including vegetation treatments, have the potential to affect the economic and social environment of the region.

The extent of potential effects would vary from state to state because of the differing prevalence of federal lands and also because the treatment area in each state would vary, both in acreage and in percentage of land area treated, depending on local issues and needs. The most pervasive effects would likely occur in states with large amounts of public land. BLM field offices provided information on the general location of proposed treatment projects. Based on this information, over 70% of the acreage to be treated in the proposed program would occur in Idaho, Nevada, Oregon and Wyoming, all of which have large areas of public lands. The largest increase in treatment area from current levels would likely occur in Nevada, where more than 6 times the current treatment acreage is proposed for treatments using all five methods under consideration.

This PER is programmatic in nature and very broad in scale. A programmatic analysis at this scale does not permit the completion of a detailed, quantitative social and economic analysis. Therefore, only general effects and expected trends are addressed here. Concerned individuals should be assured that more detailed, site-specific analyses would be conducted during the development of specific treatment projects. Public participation in the development of the details of such proposals would be encouraged at appropriate times in those processes.

Scoping Comments and Other Issues Evaluated in Assessment

Among the major concerns identified during scoping were the ecological costs and benefits to local communities and residents from treatments. Some individuals proposed that the BLM's needs for people and fiscal resources should be addressed, as should costs to state and local governments and private individuals, including secondary costs from such things as loss of recreational opportunities. Environmental justice issues—disproportionate effects on minority, low-income, and child populations—and Indian Trust issues were raised. Several comments addressed potential economic effects on ranchers from grazing restrictions or changes to forage productivity, while others questioned whether grazing permittees would pay for a portion of the treatment costs. A few respondents questioned whether the BLM would perform the treatment work or contract it out, others proposed contracting to local vendors, and some were concerned about potential economic effects on local fire fighters. Beneficial and detrimental effects of the proposed treatment program that pertain to these issues are addressed in this PER, as limited by the scale of the potentially affected geographic area and the necessarily inexact nature of the program in advance of specific treatment project proposals.

There are numerous stakeholders throughout the U.S. with differing needs and perspectives; all of their interests must be taken into consideration when planning the overall treatment program and subsequent implementation plans. On a local level, stakeholders include people in communities located in the vicinity of public lands, such as adjacent landowners, local businesses, users of public lands (e.g., ranchers and recreationists), as well as the county and state governments that benefit from BLM revenues. On a national level, the stakeholders include all taxpayers, whose tax dollars support BLM programs and who have partial "ownership" of federal public lands. Given the wide range in stakeholders whose needs and interests must be considered, many different and often conflicting opinions must be considered. A balance of both national and local interests must be pursued.

Resource Program Goals

The BLM is required to manage public lands on the basis of multiple use and sustained yield and to meet the needs of present and future generations. As the human population continues to increase and social values evolve, resource conflicts are likely to increase. In addition, the American public is increasingly aware of the importance of public lands to its well-being, and is demanding a larger voice in resource management decisions. In this context, BLM program planning must take into account a constant balancing of competing needs, interests, and values.

By statute, regulation, and Executive Order, the BLM must address social and economic issues in the preparation of programs affecting planning decisions for public lands. Section 202(c)(2) of FLPMA requires the BLM to integrate physical, biological, economic, and other sciences in developing land-use plans (43 United States Code [USC] 1712(c)(2)). FLPMA regulations 43 CFR 1610.4-3 and 1610.4-6 also require the BLM to

analyze social, economic, and institutional information. Section 102(2)(A) of NEPA requires federal agencies to "insure the integrated use of the natural and social sciences . . . in planning and decision making" (42 USC 4332(2)(A)). Federal agencies are also required to "identify and address . . . disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States" in accordance with Executive Order 12898 on Environmental Justice.

In the context of these issues and regulatory guidance, the overall goals of the vegetation treatment program are to sustain the condition of healthy lands and to restore degraded lands. From the perspective of social and economic issues, the objectives are to accomplish these goals while minimizing adverse effects and optimizing beneficial effects for affected communities. For example, reducing hazardous fuels in the WUI would, over the long term, reduce economic losses from wildland fire. Reducing the spread of invasive plant species would improve the productivity of grazing lands for both domestic livestock and wildlife, which would be economically beneficial to ranchers and advantageous for sightseeing, thus benefiting recreation-oriented businesses as well.

Standard Operating Procedures

Vegetation treatment projects would affect local social and economic resources; some effects would be beneficial while others could be adverse. Following certain SOPs would reduce adverse effects; Table 2-5 lists a number of SOPs designed to minimize unintended adverse effects of treatment projects. These SOPs include posting treatment areas; notifying adjacent landowners, grazing permittees, the public, and emergency personnel of treatments; controlling public access to treatment areas and observing restricted entry intervals given on herbicide labels; consulting with Native tribes that might be affected by the project; and, to the degree possible within the law, hiring local contractors and purchasing supplies locally.

Adverse Effects of Treatments

General Effects

It is expected that communities that are particularly dependent on a single industry would be more susceptible to the effects of vegetation treatment projects than other, more diverse, communities. In particular, ranching communities and recreation-dependent communities could be more affected than more diversified communities. However, it is not possible to identify effects on particular communities at this scale of analysis.

The vegetation treatment program would only apply to public lands; this PER does not attempt to predict possible decisions or actions by other agencies or private individuals. Also, it is not expected that any of the alternatives would significantly affect ongoing, long-term trends such as the increasing demand for outdoor recreation or the relatively high growth rates in urban, suburban, and rural populations, particularly in states from the Rocky Mountains to the Pacific.

It is assumed that vegetation treatment programs would meet, to varying degrees, the identified need for reducing the risk of wildland fire and improving ecosystem health. Vegetation treatments would reduce the amount and concentration of hazardous fuels, especially in the WUI, but also in the back country. As a result, the number, size, and severity of wildland fires would be reduced, as would the cost of wildland fire suppression and the risk of loss of life and property. Treatments that improve ecosystem health could increase or improve the amount and quality of commercial and casual uses of public lands, improve or maintain market and non-market values of public land resources, and reduce the cost of operations on public lands. However, it is not possible to quantify these benefits at this programmatic level of analysis since there is uncertainty as to when, where, and how specific treatments would occur.

Social effects of individual vegetation treatments are, for the most part, impossible to differentiate at the scale addressed by this PER. The potential for social effects would depend on people's perceptions about health and safety risks associated with different treatments. Data on such perceptions are not available, and could differ from one community to another, depending on the level of knowledge in the community about vegetation treatment methods and past experiences with these methods. The Human Health and Safety section in this chapter discusses health and safety issues related to the proposed treatments in more detail.

There is some potential for adverse effects on the social fabric of communities, depending on the success of vegetation treatment programs. Successful improvement in the productivity of rangeland, for example, would help sustain a ranching-dependent community, whereas lack of success could lead to additional economic

pressure on the community, which would tend to encourage emigration. Successfully reducing hazardous fuels in the WUI could encourage people to remain in, or move to, a community, whereas major fire losses, particularly in smaller communities, could encourage some people to move away. These potential effects are somewhat speculative, but should be examined more closely at the project-specific level.

Economic effects of vegetation treatment on communities could be similar to social effects. Changes in range productivity, wildfire risk, and access to or attractiveness of recreation activities could potentially affect employment opportunities and income levels in a community, in either a positive or negative fashion. As with social effects, however, the broad scale of this PER and the lack of data preclude the ability to accurately predict whether and where such effects would occur, and to what degree they would be beneficial or adverse.

Population and Demography

None of the proposed treatment methods is likely to cause substantive changes to existing patterns and trends in population or demographic conditions in the western states. In particular, it is unlikely that vegetation treatments would either exacerbate or counteract the trend of out-migration from small rural communities.

Environmental Justice

Executive Order No. 12898, "*Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations*" (59 FR 7629), is "intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority communities and low-income communities access to public information on, and an opportunity for participation in, matters relating to human health and the environment." It requires each federal agency to achieve environmental justice as part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects, including social and economic effects, of its programs, policies, and activities on minority and low-income populations.

Environmental justice concerns are usually directly associated with effects on the natural and physical environment, but these effects are likely to be interrelated with social and economic effects as well. Native American and Alaska Native access to cultural and religious sites may fall under the umbrella of environmental justice concerns if the sites are on tribal lands or a treaty right has granted access to a specific location.

USEPA guidelines for evaluating potential adverse environmental effects of projects require specific identification of minority populations when either a minority population exceeds 50% of the population of the affected area, or a minority population represents a meaningfully greater increment of the affected population than of the population of some other appropriate geographic unit.

Public lands occur predominantly in rural areas. There are large minority populations in rural areas of the West and Alaska, particularly Hispanics and Native Americans. Approximately 63% of the nation's Hispanic population, 68% of the nation's American Indian population, and 50% of the nation's Asian/Pacific Islander population reside in the western U.S., which contains less than 32% of the nation's total population (Table 3-15). In addition, Hispanics represent a large percentage of the total population of some states, particularly New Mexico, California, Texas, and Arizona. Similarly, Alaska, New Mexico, and several other western states have disproportionately large percentages of Native Americans and Alaska Natives. Issues of concern might include the propensity of Native Americans and Alaska Natives to use native plants for cultural and traditional purposes, and the potential for vegetation treatments to damage some of these native plants if projects are not carefully planned and implemented. This combination of factors suggests the possibility that any significant effects associated with vegetation treatments could disproportionately affect these minority populations. Potential effects specific to the individual treatment methods are addressed in later sections.

It is not possible to determine whether minorities or low-income populations would actually be disproportionately affected at this broad scale of analysis, because it is not known if treatment areas would coincide with concentrations of minority or low-income populations, or with Native American and Alaska Native use areas. Specific evaluations of environmental justice effects would be conducted in concert with environmental analyses for site-specific treatment project proposals.

Issues specific to Native Americans (such as subsistence gathering of rangeland products) have been addressed in more detail in the Cultural and Paleontological

Resources section, but they, too, must be addressed in detail during project-specific analyses.

Protection of Children

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks,* instructs federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children, and to ensure that their policies, programs, activities, and standards address disproportionate risks to children that result from environmental health or safety risks. Children could have a greater chance of being exposed to health and safety risks associated with vegetation treatments than adults because they typically spend more time outdoors, and because they tend to be more vulnerable to adverse effects from exposure to environmental contaminants. Although children may spend more time outdoors, they are not often on public land without adult supervision because of the remoteness of most of these areas. Thus, the increased opportunity for exposure would generally be negligible to minor. If there were potential risks for adverse effects to people who happen to be outside in the vicinity of vegetation treatments, a project could have a disproportionate effect on children.

Employment and Income

Most employment and income effects from vegetation treatment projects would be beneficial. However, there could be some temporary loss of jobs and income if access to treated areas was restricted for rehabilitation of vegetation. Most closures would be expected to last for no more than one growing season. Where vegetation was completely removed, however, it is possible that closures would last longer, particularly in areas with arid climates and relatively poor soils. If long-term closures occurred over large acreages and conflicted with important grazing or recreation areas, they could result in job losses and associated reductions in income. Employment and income losses would have the greatest effect on smaller communities, where alternative employment opportunities would be scarce, and where these losses would represent a larger portion of the economy than they would near larger, more diversified towns and cities.

Regardless of the local economic situation, employment and related income effects would normally be short-term in nature and geographically dispersed, primarily affecting specific communities rather than large regions of the 17-state study area.

Perceptions and Values

There would be a range of stakeholder perceptions and values associated with the various vegetation treatment methods. For example, individuals who have an aversion to chemical use in the environment could find herbicide treatments offensive. Alternatively, individuals with a much greater concern about wildfires or the effects of invasive species would likely favor the most efficient means of attacking vegetation problems. Westerners that are against government ownership and management of large land areas might be opposed to the substantial expansion of the BLM-administered vegetation treatment program, but somewhat encouraged by plans to employ private contractors for some of the treatment work. These individuals would presumably favor the most efficient means possible to reduce fire risk and improve range productivity. Some individuals place high values on the health and pristine nature of public lands, and would therefore prefer to see that the least intrusive methods be implemented. Generally, most of the treatment methods have similar negative and positive responses to these perceptions and values.

Economic Activity and Public Revenues Generated from BLM Lands

Commercial activities that occur on public lands could be adversely affected by vegetation treatments in the short term. Treatments would not directly affect mineral resources but could temporarily reduce access to such resources. Treatments would be unlikely to cause a significant reduction in BLM revenues generated from mineral leases. Most of the BLM's mineral lease revenues come from Alaska, Colorado, and Montana (see Table 3-18), where only about 11% of the proposed vegetation treatments would occur. Further, restrictions on access for these activities would likely be minimal in most places because durable road access is generally required for commercial mineral extraction ventures. Consequently, any adverse effects on employment and revenue from mineral production due to vegetation treatments would likely be very minor.

Historically, nearly all of the BLM's revenues from timber sales have come from Oregon. In 2004, timber sales amounted to $23.4 million and nearly all timber revenues were from Oregon ($23.3 million, Table 3-18), where about 14% of all vegetation treatments are proposed to occur. No adverse effects on timber sale activities are anticipated from implementation of the vegetation treatment program.

Effects on harvesting non-timber plant products would depend on the product and the design of specific vegetation treatment projects. Indiscriminate use of any treatment method could potentially damage resources or reduce their value. Public involvement in project planning and environmental review should be encouraged to minimize adverse effects and maximize benefits.

Vegetation treatments would necessitate that some sites be closed to grazing activities during treatments and for a suitable recovery period afterward, both for effectiveness of the treatment and, in some cases, for safety of the livestock. Treatments requiring temporary rest from grazing would result in a reduction in forage for livestock. Although alternative grazing sites might be available, the costs associated with grazing in a different area would likely be higher. The economic effects of temporarily reducing forage production and/or access would vary depending on the size and flexibility of the affected ranching operations. It is not possible to quantify the effects at the 17-state regional scale. As for other vegetation products, public involvement in project planning and site-specific environmental review should be encouraged to minimize adverse effects on grazing and maximize benefits.

Recreation-based businesses such as outfitters, bait shops, OHV sales and repair shops, fish and hunting shops, and outdoor gear and equipment rental shops are direct beneficiaries of recreation use of public lands. Other services such as gas stations, restaurants, and hotels that are frequented by recreationists also benefit. Temporary closure of a popular recreation site, either to protect public safety during vegetation treatments or to decrease user-related effects during a site's post-treatment recovery, would result in temporary losses of revenues to surrounding businesses. In most cases, these effects would be short term in nature, lasting only as long as the site closure. In general, most recreational activities would continue, but would shift to other locations. Depending on the location of the alternate use area, the economic benefits could shift from one community to another. If there were a suitable nearby alternative to the closed site, the effects on surrounding businesses would be minimal; if not, the businesses would be adversely affected for a period of time. It is not possible to quantify the potential effects at the 17-state regional scale, or to identify communities or specific businesses that would benefit or be harmed from potential shifts in recreational activities.

Recreation provides revenues to the BLM through fees and permits. Closure of a popular fee-based recreation site would result in a loss of revenues to the BLM. The severity of any such losses cannot be determined at this scale because no specific fee-based recreation sites have been identified for treatment. Detailed effects would be examined at the site-specific project level.

Expenditures by BLM

Vegetation treatments would require a large commitment of financial resources by the BLM, which would vary by treatment method, location, terrain and other factors. The most cost-effective treatment method would be the one that would produce the greatest benefits for the least amount of financial investment. However, the cheapest method, if it did not substantially improve the health of the land, could require indefinite repeat treatments, thus costing more money over the long term. Benefits to the health of public lands depend on the specific problem to be addressed in each specific area. Consequently, these benefits would be evaluated on a site-specific basis as project proposals were developed, and the costs for the preferred treatment method would be determined at that time.

Effects on Private Property

Vegetation treatments could affect private property in the vicinity of public lands, particularly parcels adjacent to treatment areas. Over the short term, there would be minor risks for property damage associated with the effects of treatments extending beyond public land boundaries onto private property. Under such a scenario, crops or forage could be lost. Generally, losses would be minor and short term in nature, although the relative size of the affected property would be a factor in the degree of damage accruing to the property owner.

Effects of Fire Treatments

Approximately 2.1 million acres are proposed for vegetation treatment with fire. Nevada (24%), Wyoming (20%), and Oregon (16%) would be the largest users of prescribed burn treatments. Adverse effects from use of fire include the risk that a prescribed burn would escape control. While the probability of such an occurrence is low, individual events in the past have occasionally been catastrophic, and public awareness is high because of the publicity major fires garner. Fires escaping control could have several adverse effects, including damage to private property, damage to recreational opportunities, loss of forage on public lands, potential loss of revenue to recreational businesses and ranchers, and increased costs to federal, state, and local public agencies to combat the fires.

They would also exacerbate concerns among a portion of the public about the advisability of using fire as a treatment method. Public concerns could cause conflict within communities near proposed burn areas or between concerned citizens and BLM personnel.

Although fires escaping control would cause the greatest adverse effects, they would not be common. Most prescribed fire treatments are relatively small and are successfully kept within planned boundaries. Adverse effects from controlled burns would include primarily smoke and aesthetic effects, both of which would be temporary in nature. Potential health risks from smoke are addressed in the Human Health and Safety section of this chapter. To the extent that fire treatments would be employed in low income and minority areas, health risks could cause environmental justice concerns. Similarly, if fire treatments were used near communities, they could raise concerns regarding the protection of children. Burn treatment areas would suffer from degraded aesthetic qualities both during the actual burning and for a period of a year or more afterward, which could adversely affect the quality and desirability of recreational opportunities in the area of the burn. Certain recreational features, such as trails and OHV routes, could be closed to the public for a period of time, pending successful revegetation of burn areas. In some areas, the loss or restriction of recreational opportunities would adversely affect businesses that either directly or indirectly depend on recreationists.

Effects of Mechanical Treatments

Mechanical vegetation treatments are proposed for over 2.2 million acres, with nearly half of the acreage (47%) in Nevada. Idaho would be a distant second with approximately 18% of the total. The type of mechanical treatment employed would be the major determinant of whether adverse effects would result. Mowing, for example, would have minimal effects, most of which would be considered beneficial by the public. Most mechanical methods involve use of heavy equipment, however, and are more disruptive. Chaining, for example, requires use of a pair of large crawler type tractors, which would generate noise and exhaust odors and would typically leave torn up soil and substantial amounts of debris in their wake. Some of the plant debris would remain for several years after the treatment and would degrade slowly, especially in arid and semiarid areas like Nevada, southern Idaho, eastern Oregon, and Utah. Adverse effects would be mainly aesthetic, but could physically disrupt certain recreation uses. In either case, the effects would be reduced desirability of a treated area for recreation, which could adversely affect recreation-dependent businesses as well. There would also be some potential for loss of grazing values until a disturbed area was successfully revegetated.

Effects of Manual Treatments

Slightly less than 271,000 acres are proposed for manual treatment. Manual treatments are particularly suited to small problem sites and areas, such as Oregon forestlands, where other treatment methods would be difficult to use or would be undesirable because their detrimental effects would outweigh their benefits. Adverse social or economic effects from manual treatments would be unlikely and would be minimal, at worst.

Effects of Biological Treatments

Biological treatments are proposed for approximately 454,000 acres of public land. Over 87% of the acreage would be in just three states: California (40%), Montana (35%), and Idaho (12%). Biological treatments could range from containment using domestic livestock to use of specific insects or pathogens to control unwanted plant species. Generally, there would be few, if any, adverse social or economic effects from use of domestic animals. There could be temporary, short-term interference with some recreation activities that would adversely affect recreation-dependent businesses, but the losses would likely be minor.

It is assumed that any insects or pathogens used for vegetation treatments would be properly tested and approved prior to use. There have been past occurrences, however, in which a species introduced for a positive purpose was later found to cause a different problem. For this reason, and because of the publicity such events have received, there could be public concerns about the use of insect or pathogen treatments. Efforts should be made to inform and educate the public in the vicinity of a proposed project to minimize adverse public perceptions about the use of these treatment methods.

Effects of Chemical Treatments

Chemical treatments are proposed for approximately 932,000 acres in 14 states. The largest application areas would be in Idaho (28%), Nevada (22%), and Wyoming (16%); no chemical treatments are proposed for Alaska, Nebraska, or Oklahoma. There is some potential that chemical treatments would disproportionately affect minority or low-income populations and children,

depending on where the treatments were located, although it is not possible at the scale of the PER to determine if such effects would occur. The Human Health and Safety section of this chapter, Chapter 4 of the PEIS, and the HHRA (PEIS Appendix B) all address health and safety issues that could influence the likelihood of environmental justice effects.

Chemical treatments have the potential to adversely affect plants used for ceremonial purposes by Native Americans because herbicides can affect non-target species or plants outside the application area. Similarly, there is some potential for chemical sprays to migrate onto private land or into areas used for grazing or recreational activities on public lands, especially when applied from the air. Such effects could adversely affect ranching or recreation-dependent business revenues in certain localities, although specific locations cannot be identified at the 17-state regional scale of this PER.

As with other treatment methods, chemical treatments would require closure of some treatment areas to grazing and recreational activities. Such closures would be temporary and typically short term, but might be somewhat longer in duration than other methods because, in some cases, chemical residuals could be a more persistent concern for adverse human or animal health reactions. Closures could adversely affect ranching or recreational economic activity.

Use of chemicals is often controversial, due to public perceptions about risks associated with chemicals. Efforts to inform and educate the public on specific project proposals prior to implementation would be advisable to ensure that public perceptions are based on facts rather than fears.

Standard operating procedures noted above and in greater detail in Chapter 2 would serve to minimize the potential adverse effects of chemical treatments. Also, project-specific environmental reviews would identify specific locations where effects would accrue.

Both beneficial and adverse effects of chemical treatments are addressed in greater detail in Chapter 4 of the PEIS.

Beneficial Effects of Treatments

General Effects

As noted above, there is no site-specific information on which types of treatment would be used in any particular area. Consequently, there is little or no discussion of specific treatment parameters and it is not possible to identify effects on particular communities at this scale of analysis.

It is assumed that vegetation treatment programs would meet, to varying degrees, the identified need for reducing the risk of wildland fire and improving ecosystem health. Vegetation treatments would reduce the amount and concentration of hazardous fuels, especially in the WUI, but also in the back country. As a result, the number, size, and severity of wildland fires would all be reduced, causing a reduction in the cost of wildland fire suppression and the loss of life and property. Treatments that improve ecosystem health may increase or improve the amount and quality of commercial and casual uses, improve or maintain market and non-market values of existing uses, and reduce the cost of operations on public lands. However, it is not possible to quantify these benefits.

There would be potential beneficial effects on the social fabric of communities. Successful improvement in the productivity of rangeland would help sustain ranching-dependent communities. Successfully reducing hazardous fuels in the WUI could encourage people to remain in, or move to, a community. These potential effects should be examined more closely at the project-specific level.

Economic benefits of vegetation treatments on communities could be similar to social benefits. Improvements in range productivity, wildfire risk, and access or attractiveness for recreation activities would potentially improve employment opportunities and income levels in a community. The broad scale of this PER makes it impossible to quantify beneficial effects or to accurately predict whether, where, and to what degree they would occur.

There would be both direct and indirect economic effects from implementation of the vegetation treatment program. These effects would vary depending on several factors, including the treatment method selected for use. There would be dramatic differences in costs associated with different methods and with the different circumstances of each particular project. Treatment costs could vary from as little as $20 per acre for some applications of prescribed fire to as much as $700 per acre for difficult, remote manual treatments (see Chapter 2 and below). Regardless of the level of cost, expenditures by the BLM for labor, materials, and equipment would contribute to economic activity in the vicinity of a particular treatment project.

Population and Demography

None of the proposed treatment methods would be likely to cause substantive changes to existing patterns and trends in population or demographic conditions in the western states. While there would be some increased employment generated by the increase in BLM acreage treated under each method, the jobs would generally be temporary positions or contracted work, which would not be sufficient to encourage measurable immigration of workers and their families. With some exceptions, including pilots, certified herbicide applicators, and heavy equipment operators, jobs generated by the increased vegetation treatments program would tend to pay moderate wages. Depending on the size and duration of any particular treatment project, there could be small, localized population increases, but it is not possible to ascertain if, or where, such changes would take place at this time. It is likely that any such growth would be viewed as a benefit in most communities in the West.

Environmental Justice

It is not possible to determine whether minorities or low-income populations would be disproportionately affected at this broad scale of analysis because it is not known if treatment areas would coincide with concentrations of minority or low-income populations, or with Native American and Alaska Native use areas. Specific evaluations of environmental justice effects would be conducted in concert with environmental analyses for site-specific treatment project proposals. There could be small benefits for minority and low-income populations in localities where employment opportunities were created.

Employment and Income

All of the vegetation treatment methods would produce economic benefits to western states and affected local communities by providing employment and labor income opportunities. The BLM would require the services of herbicide applicators, pilots, equipment operators, laborers, and others, creating jobs and generating income. The benefits are not quantifiable at the scale of this analysis; they would be small in the context of the 17-state region, but could be significant for some communities near larger treatment projects, depending on the expertise and availability of personnel in the relevant BLM offices and in the communities.

Although local effects cannot be determined at the scale of this PER, more specific economic effects would be determined through NEPA analysis at the time specific projects were proposed and analyzed. Regardless of the local economic situation, the nature of treatments indicates employment and related income effects would be short-term in nature and geographically dispersed, particularly benefiting certain communities throughout the 17-state area. In general, it is expected that communities located in areas with large amounts of public lands, and therefore the most potential treatment acreage, would be most likely to receive the greatest employment and economic benefits. Nevada, Idaho, Oregon, and Wyoming are the four states with the largest anticipated treatment acreage, which suggests that communities in these states would also be among the most likely to benefit from employment and income opportunities. Employment and income effects would be greatest in smaller communities, where the increases in jobs and dollars would have a greater influence on the area economy than they would near larger towns and cities.

One of the priorities of the *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-Year Comprehensive Strategy Implementation Plan* (USDI and USDA 2002) is to promote community assistance and increase contracting and jobs for forest health management. In FY 2004, the Department of the Interior assisted over 14,000 communities with risk assessment plans, fuels hazard treatments, wildfire preparedness, training, and other activities needed to reduce the risk of loss of life and property to local communities (USDI BLM 2006c). In addition, over $140 million in contracts were given out, and a meeting was held to discuss opportunities for expanded use of woody biomass as by-products of hazardous fuel reduction and forest restoration treatments.

Perceptions and Values

Individuals with a concern about wildfires or the effects of invasive species would likely favor the most efficient means of attacking vegetation problems, regardless of the method involved. Some westerners might be encouraged by plans to employ private contractors for some of the treatment work.

Invasive Species Control Cost Savings

Estimating the environmental and economic damages caused by invasive vegetation and the environmental benefits and cost savings from treating invasive vegetation, cannot be quantified at the 17-state regional scale. However, on a national scale, the costs of treating

invasive vegetation can be enormous. For example, purple loosestrife, which occurs in 48 states, costs approximately $45 million per year to control (ATTRA 1997). A total of $100 million is spent annually on aquatic invasive species control in the U.S. (U.S. Congress Office of Technology Assessment 1993). In U.S. agriculture, crop losses due to weeds are estimated at $24 billion annually, and costs of herbicide treatments are about $3 billion annually (Pimentel 1997, 2005; Pimentel et al. 2005). Forage losses due to weeds total about $1 million annually, and ranchers spend about $5 billion annually to control invasive vegetation in pastures and rangelands. Total direct and indirect costs of leafy spurge in Montana, South Dakota, and Wyoming are estimated at nearly $2 million annually for wildlands and up to $46 million annually for grazing lands (Bangsund and Leistritz 1991; Bangsund et al. 1993). Annual losses from knapweed in Montana are estimated at over $40 million annually (Hirsch and Leitch 1996). The Oregon Department of Agriculture (The Research Group 2000) evaluated the impacts of 21 species of weeds and estimated that both existing and potential invasive weeds are costing Oregon about $100 million annually.

Studies that have attempted to project the costs and benefits of treating leafy spurge have shown that benefits could total over $50 million or more annually if leafy spurge is controlled in the Great Plains region (Bangsund et al. 1997, 1999a). Still, net returns per acre are often negative early in the treatment program, with gains in net return not seen until 10 years or more after treatment, and the greatest returns from ground spraying rather than aerial spraying programs (Bangsund et al. 1996, 1999b; Hartmans et al. 1997). The cost of treating 50 acres of public lands using a single application of herbicides and a single attempt at revegetation has been estimated at $7,500 at year 0 (Kadrmas et al. 2003). However, if the 50 acres were not treated and the weeds continued to spread, weeds would cover an estimated 182 acres by year 18, and the amount required to restore a healthy ecosystem would be approximately $27,000.

Wildland Fire Cost Savings

For all of the treatment methods, approximately half of the treatment acreage would be in the WUI. Neither the fire suppression cost savings nor the reduction in property losses can be quantified at the 17-state regional scale. The potential savings should be addressed further in environmental reviews for specific projects, although they may not be quantifiable even at that scale because of the number of variables contributing to when and where a fire may start and how much damage it may cause. Relevant variable factors include weather conditions, terrain, human acts of omission and commission, and structure type and density, among others. Further, it may take several years to build a sufficient experience base of data to quantitatively estimate the benefits of treatments associated with reduced damage and wildfire suppression costs. The Forest Service and BLM came to similar conclusions when trying to ascertain the effects of vegetation treatment activities on future fire suppression costs in the Interior Columbia Basin (USDA Forest Service and USDI BLM 2000b).

During 2005, the federal government spent about $984 million on fire suppression. On average, the Department of the Interior and Forest Service spent approximately $170 per acre to suppress fires during 1996 through 2005. In addition, these agencies spend approximately $24 million annually rehabilitating burned areas (USDI BLM 2006c). Despite the lack of quantifiable data, it is expected that vegetation treatments in both WUI and non-WUI areas would reduce hazardous fuels, including invasive weeds, which contribute disproportionately to fire risk. Downy brome provides one example of the potential cost savings from attacking invasive weeds. The costs of fighting downy brome-fueled fires have been estimated at around $20 million per year, and up to $15 million annually in southern Idaho alone, including rehabilitation costs (Duncan and Clark 2005). Consequently, it is expected that all of the alternatives would reduce the cost of fire suppression in the backcountry as well as in the WUI.

Economic Activity and Public Revenues Generated from BLM Lands

Treatments would result in long-term improvements in the condition of forest resources on public lands and would lead to increases in revenues generated from forest products over the long term. The potential effects are not quantifiable at the scale of this PER.

Effects of treatments on harvest of non-timber vegetation products would depend on the product and the design of specific vegetation treatment projects. Indiscriminate use of any treatment method could potentially damage resources or reduce their value, but control of undesirable, invasive plants could enhance habitat for desirable species. Public involvement in project planning and environmental review should be encouraged to minimize adverse effects and maximize benefits.

Forage production could decrease initially following treatment, but production would likely increase over the long-term as woody vegetation and weed species were controlled, increasing the suitability of rangeland areas for grazing. Treatments would result in an increased quantity and quality of forage, increased animal production, reduced fire hazard, and a reduced risk of sickness in livestock as a result of ingesting poisonous plants. As for other vegetation products, public involvement in project planning and site-specific environmental review should be encouraged to minimize adverse effects and maximize benefits.

Treatment Expenditures by the BLM

Vegetation treatments, as proposed, would require a large financial investment by the BLM, which would vary by treatment method. These costs represent a substantial input of financial resources into the states and communities surrounding public lands, particularly in areas where public lands are extensive. The following paragraphs address the range of expected expenditures by treatment method.

Prescribed Fire. Use of fire for vegetation treatment is typically one of the least costly means of addressing unwanted vegetation. During 2005, it cost the BLM approximately $593 and $317 per acre to treat hazardous fuels in the WUI using fire and mechanical methods, respectively. During 2006, it cost the BLM approximately $373 and $236 per acre to treat hazardous fuels in the WUI using fire and mechanical methods, respectively. These costs primarily reflect the cost of implementation, although some overhead costs are included. Costs for treating hazardous fuels in 2005 were greatest in New Mexico ($726/acre) and Wyoming ($684/acre) and least in Alaska ($86/acre) and Arizona ($180/acre; USDI BLM 2006c, d).

During 2005, it cost the BLM approximately $585 and $239 per acre to treat hazardous fuels in non-WUI areas using fire and mechanical methods, respectively. During 2006, it cost the BLM approximately $171 and $105 per acre to treat hazardous fuels in non-WUI areas using fire and mechanical methods, respectively. Costs for treating hazardous fuels were greatest in California ($1,331/acre) and Nevada ($899/acre) and least in Wyoming ($53/acre) and Alaska ($78/acre).

Although the costs range from $50 per acre to $1,300 per acre depending on the location of the burn (higher costs are associated with treatment of forest lands in California and Oregon and lands in the WUI), the cost in most circumstances would be about $290 per acre in the WUI, and $105 per acre outside the WUI, based on average treatment costs during 2002 to 2006 (USDI BLM 2006c). With 2.1 million acres proposed for fire treatment, and assuming treatments would be about equally split between the WUI and non-WUI, this method would require an expenditure of at least $400 million (more if Pacific Northwest forestlands receive fire treatment), similar to what the BLM and Forest Service currently spend on hazardous fuels reduction using all treatment methods (USDI BLM 2006b). Prescribed fire would be the second most labor intensive of the five proposed methods, with approximately 58% of the cost typically going toward payments to labor (USDI BLM 1991a). No data are available on how much of the labor costs would go to existing BLM staff and how much would go toward hiring outside contractors and/or workers.

Mechanical Treatment. The range of costs for mechanical treatments is also quite broad: from $100 to $600 per acre. Using a midpoint of $350, the 2.2 million acres proposed for mechanical treatment would require an expenditure of $770 million. The range of costs reflects the range of possible types of mechanical treatments, some including just mowing and others employing multiple large pieces of heavy equipment (see Chapter 2). The type of terrain and the type and size of vegetation requiring treatment would also affect the cost. Mechanical treatment would direct approximately 39% of the expenditure, or $300 million, to labor costs (USDI BLM 1991a). The types of workers required would include mainly skilled equipment operators, who would be relatively highly paid. It is expected that a significant, but unquantified, portion of mechanical treatment work would be contracted out. Consequently, there would be a substantial number of non-government jobs supported by this treatment method.

Manual Treatment. Estimated costs for manual treatments range from $70 to $700 per acre. Manual treatment is the most labor intensive of the five methods proposed, with approximately 92% of the cost going to labor (USDI BLM 1991a). Manual treatment is the least favored method in the proposed program, accounting for only 270,910 acres. At the $385-per-acre midpoint of the cost range, the program would require an expenditure of $104 million, approximately $96 million of which would go to labor. It is likely that many of the jobs would be filled by unskilled laborers at relatively low wage levels, although specific labor requirements are not known.

Biological Treatment. Costs for biological treatment vary depending on the type of organism employed. Use of domestic animals—cattle, sheep or goats—is quite inexpensive, in the range of $12 to $15 per acre. This method has limited efficacy, however, and animals require continuous management to be productive. Use of biological control agents such as insects, nematodes, mites or other pathogens is more costly, ranging from $80 to $150 per acre for ground applications and $150 to $300 per acre for aerial applications. Based on information provided by field offices, about two-thirds of the acres subject to biological control would be treated using domestic animals, and the remainder using biological control agents. Assuming an average treatment cost $13.50 per acre for domestic animal use, and $150 per acre for biological control agents, treatment of the proposed 453,750 acres would result in a total cost of approximately $26.8 million. No data are available for the labor component of biological treatment, but it could be assumed that the labor component would be a relatively small part of the total.

Chemical Treatment. Chemical treatment costs are divided between the cost of the herbicide selected and the cost of applying it. As itemized in the PEIS, the herbicide costs range from about $1 per acre for ground-applied tebuthiuron to over $125 per acre for ground-applied bromacil (see Table 3-23). In addition to the chemical costs, there would be costs for applying the herbicides. The Forest Service estimated the average cost at $100 per acre for ground application and $25 per acre for aerial application (USDA Forest Service 2005). The BLM's range of estimated application costs is even broader. For ground applications, these estimates range from $50 to $300 per acre for backpack or ATV applications and from $25 to $75 per acre for boom sprayer applications. Aerial applications are estimated at $6 to $40 per acre for fixed-wing aircraft and $25 to $200 per acre for helicopters. The differences are largely due to the variation in labor and time required to cover an acre by each application mode. It takes many more man-hours to treat an acre on foot or from a small ATV, for example, than to treat an acre with an aircraft. The portion of the total herbicide application cost attributable to labor has been estimated at 17% for aerial applications and 26% for ground applications. Assuming the overall average cost per acre would be approximately $96 per acre, application of chemical treatments on the proposed 931,850 acres would require an expenditure of approximately $89.5 million.

Summary. At best, these estimates of the costs of vegetation treatments are crude averages; actual costs would vary widely, dictated by terrain, scale of a treatment project, accessibility of the treatment area, size of the problem vegetation stand being treated, type of vegetation requiring treatment, and other factors. None of the specifics of these factors are available for evaluation at the programmatic level, but they would be analyzed in greater detail for specific projects as they were developed.

The source of labor for the five vegetation treatment methods would vary with the project. Aerial application projects would be contracted out in most cases. Ground applications would be done by a combination of contractors and BLM personnel, either full-time or part-time employees. The determination of in-house or contract application would be determined for each project individually, depending on the specific needs of the project and the capabilities of the state or local BLM offices.

If goods and services were purchased locally, or additional workers were hired locally in support of a vegetation treatment project, state and local economies would benefit both from direct local expenditures and from "multiplier" effects of the dollars circulating through additional local and state business enterprises. Further, state and local governments would benefit through increased tax revenues. The relative public benefits would depend on the taxing structure of the individual states.

An additional consideration pertaining to BLM expenditures is the distribution of payments to state and local governments (see Table 3-24). None of the vegetation treatment methods would affect these payments, since they are established by Congress; the proposed vegetation treatment program would have no effect on the formula.

Irrespective of the particular treatment method selected, the costs associated with restoring or maintaining an ecosystem through vegetation treatments is generally much less than the cost of suppressing wildfires and implementing fire rehabilitation programs (USDI 2001a). In FY 2005, $218 million was budgeted by the Department of the Interior for fire suppression; the Forest Service budget was nearly $650 million (USDI BLM 2006c). Annual costs of vegetation treatments, using the assumptions above, would be approximately $1.4 billion.

Effects on Private Property

Over the long term, a reduction in hazardous fuels on public lands would reduce the likelihood of wildfires migrating from public lands to nearby private property, including both private ranch lands and private residences in the WUI. Vegetation treatments would also reduce the risks of noxious weeds spreading onto neighboring parcels, including poisonous weeds, which could harm livestock. A reduction in such risks would ultimately tend to sustain or even improve property values. Any such effects are not quantifiable at this broad scale of analysis.

Human Health and Safety

Vegetation treatments involve risk, or the perception of risk, to workers and members of the public living or engaging in activities in or near treatment areas. An important goal of treatments is to manage vegetation to reduce hazardous fuels and restore fire adapted ecosystems to reduce the incidence of loss of life and injury to the public and firefighters resulting from catastrophic wildfires. Part of this goal includes developing smoke management plans to reduce the health effects of smoke on the public, and to identify herbicides that are safe to use around the public.

A human health risk assessment was conducted for the PEIS to evaluate potential human health risks that could result from herbicide exposure both during and after treatment of public lands. The HHRA was conducted to be scientifically defensible, to be consistent with currently available guidance where appropriate, and to meet the needs of the BLM vegetation treatment program. This PER focuses on potential human health risks that could result from other treatment methods, and fire use in particular.

Risk to two types of human "receptors" would be associated with vegetation treatments: occupational receptors and public receptors. Receptors are representative population groups that could have specific exposures to the treatments. Occupational receptors considered in the HHRA include workers that mix, load, and apply herbicides, operate transport vehicles and equipment, or conduct prescribed burns. In some cases an occupational receptor may perform multiple tasks, increasing his or her exposure. Public receptors included members of the public most likely to come into contact with applied herbicides, fire, or other treatment controls.

Scoping Comments and Other Issues Evaluated in Assessment

Respondents suggested that at-risk groups like infants, the elderly, sick people, and people with sensitivities to chemicals and smoke be specifically addressed. A number of comments proposed that risk assessments be performed for both prescribed and natural fires. During public scoping, a large number of respondents during public scoping were concerned about the risks to human health from herbicide treatments. Numerous respondents urged the BLM to describe all potential toxicological hazards of herbicide chemicals, including their ability to disrupt hormone systems and immune systems. Establishing a goal of using the minimum effective dosage and developing protocols for achieving this goal was encouraged. There was also concern for the effects of herbicides on basket plants and the people who collect them, in particular Native Americans. Some respondents felt that the uncertainties about the environmental effects of herbicides and inert ingredients should be disclosed. According to some respondents, Oust® (herbicide formulated with sulfometuron methyl) should be considered for evaluation even though it was evaluated previously in the 1991 13-State Vegetation EIS (USDI BLM 1991a). One respondent noted that if there are insufficient toxicological data to be found for a specific herbicide, then that herbicide should not be used.

Resource Program Goals

Important goals of the vegetation treatment program are to ensure the health and welfare of visitors to public lands, reduce the risk of catastrophic loss of people and property from wildfires, and provide a safe work environment for workers involved in vegetation treatment activities. Treatments that remove noxious and poisonous weeds and other harmful vegetation near public use sites and facilities would benefit public health and welfare and would involve all treatment methods. Because of concern regarding the potential effects of fire use and herbicides on public health, manual, mechanical, and biological control treatments would comprise a greater portion of the treatments in areas with high levels of public use, in the WUI, in cultural and traditional use areas, and in areas where there is a risk that fire or herbicides could affect people, structures, and traditional lifeway values. Fire use and herbicides would be the predominant methods in areas where dispersed recreation occurs and where treatment of large areas is required. During all treatments, worker safety would be paramount. All treatment methods

could result in injury or death to workers if proper operating procedures were not followed.

During FY 2005, wildfires burned 6.8 million acres on public lands. Over three out of every four fires were caused by lightning, while the remainder were caused by humans (USDI BLM 2006d).

Wildfires cause the loss of life and property. According to the National Interagency Fire Center (2005), 12 people died from wildland fire-related accidents in 2005. From 1999 to 2005, the leading cause of firefighter deaths nationally, which include federal, state, and local firefighters and volunteers, as well as private individuals who were involved in direct support of wildland fire operations are: vehicle accidents (23.8%), heart attacks (22.7%), aircraft accidents (22.3%), and burnovers/entrapments (20.2%).

During FYs 2002 to 2005, 49 USDI personnel were injured conducting fire operations. During 2005, wildland fires resulted in the loss of 240 primary residences and 750 total structures on lands near BLM- or Forest Service-administered lands (USDI BLM 2006c).

Standard Operating Procedures

Standard operating procedures designed to reduce potential unintended effects to human health are listed in Table 2-5. When conducting treatments, workers would always wear appropriate safety equipment and clothing and use equipment that is properly maintained. For fire use, the BLM would use some form of pretreatment, such as mechanical or manual treatments, in areas where fire could not be safely introduced because of hazardous fuel buildup. Workers would notify nearby residents who could be affected by smoke. Those involved in fire use treatments would maintain adequate safety buffers between the treatment area and residences/structures.

When cutting vegetation, all brush and tree stumps would be cut flat, where possible, to eliminate sharp points that could injure a worker or the public. Only qualified personnel would be allowed to cut trees near powerlines, and any burning of vegetation debris would take place outside of ROWs to ensure that smoke would not provide a conductive path from transmission lines or electrical equipment to the ground. Spark arrestors would be required on all equipment to reduce the risk of accidental fire.

Workers applying herbicides would minimize application areas where possible; establish appropriate (herbicide-specific) buffer zones; post treated areas with appropriate signs at common public access areas; and notify the public of the potential for exposure. In addition, the BLM would have a copy of Material Safety Data Sheets at work sites; notify local emergency personnel of proposed treatments; contain and clean up spills and request help as needed; and secure containers during transport. The results from the HHRA would help inform BLM field offices on the proper application of herbicides to ensure that effects to humans were minimized to the extent practical.

Adverse Effects of Treatments

The health and safety of workers could be at risk from exposure to herbicides; from working on uneven ground, broken terrain, and in dense vegetation; from use of hand and power tools; from inhalation of smoke; from exposure to falling debris; and from other accidental situations. The public could be at risk from flying debris if they were near an area where manual or mechanical equipment was used. For example, rocks or other debris could fly out from under a mower or brushhog during treatments along ROWs and near public high use areas and facilities.

Sensitive members of the public, including children and the elderly, and workers could experience minor discomfort from fire use, including eye, nose, and lung irritation. Workers could also suffer burns from fires. These risks would be minimized or avoided by following fire management plans, conducting burns during periods of favorable meteorological conditions to reduce smoke effects to the public, and by using proper equipment and following proper safety procedures. As discussed in the PEIS, herbicides pose risks to workers and the public. In general, mixer/loader/applicators would be most at risk from use of herbicides, and people living in close proximity to treatment areas would also be at low to moderate risk for adverse effects from some herbicides used by the BLM.

Risks from using biological control would be similar to those common to any human activities in a wildland environment (USDA Forest Service 2005).

Effects of Fire Treatments

Approximately 2.1 million acres would be treated using fire, with Nevada, Wyoming, and Oregon accounting for over half of the acres treated. Workers and the public would be at risk from wildland fire, prescribed

fire, and fire use for resource benefits. Risks to workers and the public would include injury and fatality as a result of the fire itself, from inhalation exposure from combustion products, and from inhalation of volatized herbicide residues.

Risks from Fire

Prescribed burning presents various hazards to ground crews, who could possibly receive injuries ranging from minor to severe burns resulting in permanent tissue damage. Risks to workers would be minimized by use of protective clothing and by following standard safety procedures. The public could be exposed to similar risks if the fire escaped from the treatment area. The remoteness of most treatment areas and presence of fire crews and safety equipment would make the risk of injury to the public extremely low (USDI BLM 1991a).

Risks from Smoke

Substances that may be found in wood smoke include water, particulate matter, carbon monoxide, carbon dioxide, nitrogen oxides, aldehydes, ketones, and other substances (USDI BLM 1991a). Carbon dioxide and water make up over 90% of total mass emitted from wildland fires. Carbon dioxide may affect the global radiation budget (Sandberg and Dost 1990).

Particulate matter is the principal pollutant of concern from fires, particularly for particles less than 10 microns in diameter (Sandberg and Dost 1990, USEPA 1996). Approximately 14 to 50 tons of particulate matter is produced per ton of fuel burned. Particulate matter affects pulmonary function; and children, the elderly, and asthmatics are especially sensitive to exposure (Sandberg et al. 2002). Studies have shown that fine particles are linked (along or with other pollutants) to increased mortality and aggravation of preexisting respiratory and cardiovascular disease. Particulate matter can also affect immune systems (Ammann et al. 2001).

Although the long-term health effects from occupational smoke exposure are not well known, evidence suggests that brief, intense exposures to carbon monoxide and particulate matter can easily exceed short-term exposure limits in peak exposure situations such as direct attack and holding firelines downwind of an active wildfire or prescribed burn (Reinhardt and Ottmar 2000; Reinhardt et al. 2000). Average exposure over a worker's shift only occasionally exceeds recommended instantaneous exposure limits set by the American Conference of Governmental Industrial Hygienists, and rarely does it exceed Occupational Safety and Health Administration time weighted average limits (Reinhardt and Ottmar 2000; Sandberg et al. 2002). The long-term health effects to firefighters from smoke exposure are unknown, although there is anecdotal evidence that the incidence of cardiopulmonary disease and death may be greater than in the general population.

Smoke can cause highway safety problems when it impedes a driver's ability to see the roadway. Although this is a minor issue in the more remote areas of the West where most public lands are located, it is a problem in the southeastern U.S., where over a 10-year period 28 fatalities and 60 serious injuries were implicated with smoke from prescribed burning (Sandberg et al. 2002).

The gaseous components of smoke, including carbon monoxide, carbon dioxide, and nitrogen oxides, generally decompose or diffuse into the atmosphere relatively quickly. Emissions of carbon monoxide range from about 80 pounds per ton of wood burned for flames to 800 pounds per ton for smoldering fires. Carbon monoxide could represent a direct hazard to human health at the fireline. Carbon monoxide from prescribed fires likely poses no risk to community air quality (Sandberg and Dost 1990).

Polynuclear aromatic hydrocarbons (PAHs) are of significant toxicological concern when evaluating the effects from wood smoke because they contain at least five carcinogenic materials (USDI BLM 1991a). Aldehydes and ketones are ciliary toxicants that inhibit the removal of foreign material from the respiratory tract. Aldehydes are also known irritants that may be adsorbed onto the surface of particulate matter.

An HHRA was done in 1991 for the *Final Environmental Impact Statement Vegetation Treatment on BLM Lands in Thirteen Western States* (1991 13-State EIS) to assess the risks to workers and the public from PAHs found in wood smoke. Based on this assessment, estimated cancer risks from exposure to PAHs are not expected to exceed 1 in 1 million for any worker or member of the public, even in extreme cases.

Risks from Herbicides in Brown-and-burn Operations

Vegetation may be treated with herbicides several weeks before beginning a prescribed burn, with the goal of drying the vegetation to accomplish a more efficient burn. Herbicides that could be used for this purpose include 2,4-D, glyphosate, hexazinone, picloram, and

triclopyr. An analysis of the risk from volatilization of herbicide residues was also done as part of the 1991 13-State EIS. Based on this assessment, neither workers nor the public would be expected to be at risk from herbicide residues volatilized in a brown-and-burn operation (USDI BLM 1991a). Other studies have shown that hot fires thermally degrade most herbicides, but that smoldering fires have the potential to volatilize large amounts of some herbicides (Bush et al. 1998). Exposure analyses indicate, however, that no significant health risks occur from herbicides incorporated into forest soils. Naturally occurring chemical by-products of combustion were of greater risk to human health.

Effects of Mechanical Treatments

Approximately 2.2 million acres would be treated using mechanical methods under the proposed treatment program, which is a 3-fold increase from current levels. Most mechanical treatments would occur on public lands in Nevada, Idaho, Oregon, and Utah. About 15% of mechanical treatments that remove vegetation would involve mowing, while the remaining treatments would involve cutting, crushing, shredding, and logging.

Workers using tractors and other heavy equipment would face the same types of risks as workers using similar equipment; however, risks of severe injuries from mechanical treatments would be low if workers adhered to standard safety procedures (BPA 2000). During a 4-year period, only one BPA worker was hurt operating mechanical equipment during vegetation control treatments; similar low accident rates would be likely for BLM workers and contractors.

Contact with cutting blades, mulchers, shredders, drills, or similar equipment during operation could hurt machinery workers. Operators could be injured or killed by losing control of their equipment, which would be most likely to occur during treatments on steep slopes, near wetlands or other unstable surfaces, or in dense foliage. Rocks and other flying debris kicked up by equipment could harm the operator or other workers near the treatment site. These risks could be minimized by avoiding treatments on steep slopes or traveling perpendicular to the slope, maintaining equipment in optimal working order, and using shields on equipment to deflect flying debris. High noise levels during equipment operations could cause operators to experience partial hearing impairment. Use of hearing protection devices would help to reduce noise risks (USDI BLM 1991a). Exhaust gases could be harmful to equipment operators working in tight spaces. Workers using machinery in powerline ROWs would need to be extra careful to avoid contact with the powerline, or with vegetation touching the powerline, to avoid electrocution.

The public would be at a slight risk for injury from flying debris. Risks to the public would be greatest for vegetation treatment activities near public facilities and along ROW. Maintaining a safety buffer around treatment areas would limit the risk of harm to the public from mechanical treatment operations.

Fuels and lubricants used in mechanical equipment could spill into a stream or other water body from an accident or leak, or during refueling, potentially fouling drinking water sources. The BLM would refuel trucks, tractors, and other equipment away from water bodies, preferably at a designated fueling site, and would carry sorbents or other spill cleanup materials or equipment to work sites to clean up any minor spills that occurred during equipment operation.

Effects of Manual Treatments

Under the proposed treatment program, manual treatments would be used on about 5% of public lands. Nearly all manual treatments would involve pulling or cutting vegetation with non-motorized hand equipment or chainsaws. Workers would be exposed to a variety of risks when using hand tools and pulling weeds. Hand pulling exposes workers to the hazards of physical contact with irritant weeds, such as leafy spurge, common tansy, and poison ivy, which can cause blisters, dermatitis, and inflammation. Workers could also suffer allergic reactions to pollen from ragweed and other grasses and forbs.

Workers would be at risk from biting and sucking insects, such as ticks and mosquitoes. Certain tick species carry diseases such as Rocky Mountain spotted fever and Lyme disease. Workers could also come into contact with poisonous snakes in most regions except Alaska. Workers frightening or surprising bears and other wildlife would be at risk for attacks. Some manual treatments would occur in remote areas, especially in wilderness or other special areas where use of motorized equipment is discouraged. The time required to obtain medical treatment in remote areas might complicate some injuries (USDI BLM 1991a).

Workers implementing manual treatments should be in good physical condition. Nonetheless, physical exertion during hot weather could lead to heat stroke. Exertion could also exacerbate existing chronic health problems, such as arthritis or tendonitis, or result in a stroke or

heart attack. Falls or other accidents could also occur. When using hand tools, workers could hit or cut themselves with tools, be hit by falling trees, shrubs, or debris, or fall onto sharp equipment or the ends of cut vegetation. Injuries could range from minor scrapes to major bleeding or bone fractures. Severe injuries occurring in remote areas could become fatal. Maintaining equipment in optimal working condition and using automatic shut-off devices would help to reduce the likelihood of injury. Workers would be exposed to noise and exhaust from motorized equipment. Use of hearing protection and operation of equipment in well-ventilated areas would minimize effects to operator health.

It is unlikely that the public would be at risk from manual treatments. It is possible that flying debris could accidentally hit a person, but safety zones around work areas should minimize this possibility.

Effects of Biological Treatments

Approximately 8% of public lands would be treated using biological control methods, with half of these treatments occurring in Idaho, Montana, and Wyoming. Nearly two-thirds of all biological treatments would involve domestic animals (such as livestock). Most of the remaining biological treatments would utilize insects; pathogens would be used on less than 100 acres annually.

Livestock managers could be stepped on, trampled, kicked, or bitten by livestock, or hurt while operating vehicles when transporting livestock to or from the treatment area. Workers could also suffer minor discomfort from exposure to livestock fecal material and animal odors. Members of the public could experience similar effects if they were to come into contact with livestock. Large numbers of livestock, combined with a long period of vegetation containment, could result in large amounts of fecal material within the treatment area. If fecal material were to enter surface waters through direct deposition or from runoff, members of the public downstream from the treatment site could drink contaminated water. Using stock tanks as an alternate water source, constructing range fencing, and moving and dispersing livestock away from riparian and other aquatic areas would reduce this risk (USDI BLM 1991a).

Workers could be hurt during operation of equipment to transport and release insects and pathogens at treatment sites. Only biological control agents that have been studied and determined not to pose a risk to non-target or desirable species would be used to treat vegetation. Thus, it is unlikely that Native peoples or other members of the public would come into contact with these organisms when harvesting vegetation.

Effects of Chemical Treatments

The risks to workers and the public from the use of 24 herbicides currently available or proposed for use by the BLM were evaluated in the HHRA prepared for the PEIS (see Human Health and Safety in Chapter 4, and Appendix B). The following sections summarize the results of that assessment.

Human Health Risks by Application Method and Amount

Aerial applications of herbicides pose a greater risk to the public due to off-site drift than ground applications, as herbicides applied at greater distances from the ground are able to drift farther from the target application area. Therefore, public receptors within a larger radius of the treatment site would be at risk if the herbicide was applied aerially than if it was applied by a ground application method.

Spot applications would be less likely to pose a risk to downwind receptors than boom/broadcast applications. However, spot applications would be more likely to pose a risk to the worker charged with applying the herbicide; because these workers are more likely to come into contact with the herbicide, their exposure doses could be higher. In particular, there would be a low to moderate risk to workers applying diquat by backpack or horseback from exposure to the herbicide, whereas those applying diquat at the typical application rate by ATV or truck would not be at risk.

Most of the herbicides do not pose a risk to human receptors when applied at the typical application rate. At the maximum application rate, however, more herbicides, under more exposure scenarios, have the potential to adversely affect human health. Based on the HHRAs, fluridone, chlorsulfuron, clopyralid, glyphosate, picloram and triclopyr would not pose a risk when applied at the typical rate, but would pose a risk under one or more exposure scenarios involving applications at the maximum application rate. There would not be risks associated with scenarios involving applications of dicamba, diflufenzopyr, imazapic, imazapyr, metsulfuron methyl, or sulfometuron methyl at the maximum (or typical) application rate.

Human Health Risks by Receptor

There would be risk to workers treating vegetation with 2,4-D, 2,4-DP, asulam, atrazine, bromacil, diquat, diuron, fosamine, mefluidide, simazine, or tebuthiuron at either the typical or the maximum application rate. Atrazine and diuron pose risks to most receptors under scenarios involving the typical application rate. There would be low to moderate risks to receptors aerially applying 2,4-D, atrazine, diquat, bromacil, simazine, or tebuthiuron, even at typical rates, and most workers would be at risk when applying these herbicides at maximum application rates. 2,4-D, 2,4-DP, atrazine, and fosamine pose risks to ground applicators, particularly under scenarios involving the maximum application rate. Mixer/loaders would be at low risk during aerial applications of fluridone, and high risk during aerial applications of atrazine, bromacil, diuron, simazine, or tebuthiuron. Applicators would be at risk during ground broadcast applications of atrazine or diuron at the typical rate, and during ground broadcast applications of 2,4-DP, bromacil, chlorsulfuron, fosamine, or tebuthiuron at the maximum rate. All occupational receptors would be at risk from applying atrazine, hexazinone, tebuthiuron, and triclopyr at the maximum application rate. The rest of the potential occupational exposures would not pose a risk to receptors. Workers involved in the aerial application of herbicides appear to be at greater risk than other occupational receptors; however, the application method that poses the greatest risk to workers appears to vary depending on the herbicide, so application methods for each herbicide should be carefully evaluated with respect to potential human health effects.

In general, public receptors are less at risk than occupational receptors. However, within this category, children can be more at risk than adults. Public receptors do not appear to be at risk from applications of chlorsulfuron, dicamba, diflufenzopyr, imazapic, imazapyr, metsulfuron methyl, or sulfometuron methyl. Diquat application at the typical application rate poses low risks to child residents. When applied at the maximum rate, diquat would pose low to moderate risks to all public receptors, except swimmers. Diuron would pose risks to most public receptors under worst-case exposures. In addition, 2,4-D, 2,4-DP, asulam, atrazine (also at maximum exposure), bromacil, clopyralid, diuron, fluridone, fosamine, glyphosate, hexazinone, mefluidide, picloram, simazine, tebuthiuron, and triclopyr could pose risks to public receptors under one or more accidental exposure scenarios (e.g., exposure resulting from the spill of an herbicide into a small pond). For most herbicides (except diquat), risks to public receptors could be minimized or avoided by using the typical application rate and following SOPs that would greatly reduce the likelihood of accidents.

Beneficial Effects of Treatments

As discussed in Chapter 1, Purpose of the Environmental Report, the President and Congress have directed the BLM, through implementation of the *National Fire Plan* (USDI and USDA Forest Service 2001), and the *Healthy Forests Restoration Act of 2003*, to take more aggressive actions to reduce catastrophic wildfire risk on public lands. These actions would be taken to protect life and property, and to manage vegetation in a manner that provides for long-term economic sustainability of local communities, improved habitat and vegetation conditions for fish and wildlife, and other public land uses. As outlined in this PER, these actions include a proposed 3-fold increase in the use of fire and other treatment methods from current levels to reduce hazardous fuels and the risk of catastrophic wildfire, and the identification and evaluation of several new herbicides that could be used to treat vegetation with less risk to humans than most other herbicides currently available to the BLM. About half of this effort would be conducted in the WUI, where risks to human health from smoke and fire are greater than in more remote lands.

Unplanned or unwanted fires, such as catastrophic wildfires, can pose serious threats to public health and safety, as well as to air quality. Because these fires are uncontrolled, they can pose significant threats to the safety of firefighters and the general public and destroy property. The intense or extended periods of smoke associated with uncontrolled fires can also cause serious health problems and decrease visibility (USEPA 1998a). Wildfires cause the loss of life and property. According to the National Interagency Fire Center (2005), 12 people died from wildland fire-related accidents in 2005. Wildfires have also destroyed thousands of structures and caused the evacuations of thousands of residents in recent years.

Prescribed fires and fire use for resource benefit, on the other hand, are used to restore natural fire cycles, reduce the buildup of hazardous fuels, and restore native vegetation and natural ecosystem processes. Scheduling burning during favorable weather conditions and controlling the amount of fuel and acreage burned can minimize emissions and adverse effects of smoke on public health and the environment. In addition, fire

management agencies, including the BLM, work closely with the USEPA, the National Interagency Fire Center, and tribal, state, and local fire agencies to manage smoke from prescribed fire activities. As part of this effort to manage smoke and its health effects, wildland owners and managers are encouraged to consider alternative treatments to fire, including mechanical, manual, and chemical treatments, and reduce fuel levels before burning. Mechanical thinning and biomass utilization are part of the suite of treatments the BLM would use in areas where fire presents an unacceptable risk. If fire were to lead to violation of the PM air quality standards, the USEPA would work with states or tribes to review and upgrade smoke management programs to ensure that human health was not compromised by use of fire (USEPA 1998a, USDA Forest Service and USDI BLM 2000b).

The *Restoring Fire-adapted Ecosystems on Federal Lands: A Cohesive Strategy for Protecting People and Sustaining Natural Resources* (Hann et al. 2002) modeled the effects of existing and proposed higher levels of treatments on fire risk to ecosystems and communities. In addition, the strategy looked at the benefits of less aggressive measures, such as creating defensible space around homes, in reducing loss of property and life. Based on the cohesive strategy, aggressive actions to reduce hazardous fuels and improve ecosystem function within the WUI, similar to those proposed in this PER, would reduce the risk to people and property by about one-third.

Herbicides would be used to treat vegetation to reduce hazardous fuels, restore native vegetation, and restore natural ecosystem processes. In addition to increasing the number of acres treated with herbicides, the BLM proposes to use four new herbicides (diflufenzopyr [as a formulation with dicamba], diquat, fluridone, and imazapic) that have been shown to be effective in the treatment of aquatic and terrestrial vegetation, as well as any new chemicals that become available in the future.

Based on an HHRA, three of the four new herbicides (all except diquat) appear to be relatively harmless to humans; therefore, there would be increased options for appropriately managing vegetation while minimizing the risk to human receptors. If these three new herbicides were used in place of currently-available herbicides that are more harmful to humans, there would be fewer risks than under current herbicide treatment programs. Since diquat potentially presents greater risk to humans under many application scenarios, it should not be used, or be used only in very limited scenarios at the typical application rate, where there is no risk to human receptors (e.g., ground applications from trucks in berry gathering sites or in areas that are not near residences).

Other treatment methods (mechanical, manual, and biological control), would have negligible to minor effects on worker and public health, while still contributing to overall control of vegetation and improvement in ecosystem function.

CHAPTER 5

REFERENCES

CHAPTER 5

REFERENCES

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CHAPTER 6

GLOSSARY

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A

Active ingredient (a.i.): The chemical or biological component that kills or controls the target pest.

Acute effect: An adverse effect on any living organism in which symptoms develop rapidly and often subside after the exposure stops.

Acute toxicity: The quality or potential of a substance to cause injury or illness shortly after exposure to a relatively large dose.

Adaptive management: A system of management practices based on clearly identified outcomes, monitoring to determine if management actions are meeting outcomes, and if not, facilitating management changes that will best ensure that outcomes are met or are reevaluated.

Additive: A substance added to another in relatively small amounts to impart or improve desirable properties or suppress undesirable properties.

Additive effect: A situation in which combined effects of exposure to two chemicals simultaneously is equal to the sum of the effect of exposure to each chemical given alone.

Adjuvant: Chemical that is added to the pesticide formulation to enhance the toxicity of the active ingredient or to make the active ingredient easier to handle.

Adsorption: 1) The adhesion of substances to the surface of solids or liquids. 2) The attraction of ions of compounds to the surface of solids or liquids.

Adverse impact: Impacts that causes harm or negative result.

Aerobic biodegradation: The breakdown of organic contaminants by microorganisms when oxygen is present.

Air pollutant: Any substance in the air that, if in high enough concentration, could harm humans, animals, vegetation, or material. Air pollutants may include almost any natural or artificial matter capable of being airborne, in the form of solid particles, liquid droplets, gases, or a combination of these.

Air quality: The composition of air with respect to quantities of pollution therein; used most frequently in connection with "standards" of maximum acceptable pollutant concentrations.

Alien Species: Per Executive Order 13112, alien species means, with respect to a particular ecosystem, any species, including its seed, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem.

Allotment (grazing): Area designated for the use of a certain number and kind of livestock for a prescribed period of time.

Alluvium: General term for clay, silt, sand, or gravel deposited in the bed of a stream during relatively recent geologic time, as a result of stream action.

Alternative: In an EIS, one of a number of possible options for responding to the purpose and need for action.

Ambient air: Any unconfined portion of the atmosphere; open air and surrounding air. Often used interchangeably with "outdoor air."

Anadromous: A term used to describe fish that mature in the sea and swim up freshwater rivers and streams to spawn. Salmon, steelhead, and sea-run cutthroat trout are examples.

Anaerobic biodegradation: The breakdown of organic contaminants by microorganisms when oxygen is not present.

Animal Unit (AU): A standardized unit of measurement for range livestock that is equivalent to one cow, one horse, five sheep, five goats, or four reindeer, all over 6 months of age.

Animal Unit Month (AUM): The amount of feed or forage required by one animal unit grazing on a pasture for one month.

Annual (plant): A plant whose life cycle is completed in 1 year or season.

Aquatic: Growing, living in, frequenting, or taking place in water; used to indicate habitat, vegetation, or wildlife in freshwater.

Aquifer: Rock or rock formations (often sand, gravel, sandstone, or limestone) that contain or carry groundwater and act as water reservoirs.

Area of Critical Environmental Concern (ACEC): An area within public lands that requires special management attention to protect and prevent irreparable damage to important historic, cultural, or scenic values; fish and wildlife resources; other natural systems or processes; or to protect life or provide safety from natural hazards.

Arid: A term applied to regions or climates where lack of moisture severely limits growth and production of vegetation. The limits of precipitation vary considerably according to temperature conditions.

Attainment area: A geographic area that is in compliance with the National Ambient Air Quality Standards. An area considered to have air quality as good as or better than the National Ambient Air Quality Standards as defined in the Clean Air Act.

B

Binder: A material used to bind together two or more other materials in mixtures.

Bioaccumulation: The process of a plant or animal selectively taking in or storing a persistent substance. Over time, a higher concentration of the substance is found in the organism than in the organism's environment.

Biodegradability: Susceptibility of a substance to decomposition by microorganisms; specifically, the rate at which compounds may be chemically broken down by bacteria and/or natural environmental factors.

Biodiversity: The variety of life and its processes, including all life forms from one-celled organisms to complex organisms such as insects, plants birds, reptiles, fish, other animals and the processes, pathways, and cycles that link such organisms into natural communities.

Biological Assessment (BA): A document prepared by or under the direction of a federal agency; addresses federally-listed and proposed species and designated and proposed critical habitat that may be present in the action area, and evaluates the potential effects of the action on such species and habitat.

Biological crust: Thin crust of living organisms on or just below the soil surface; composed of lichens, mosses, algae, fungi, cyanobacteria, and bacteria.

Biological diversity (biodiversity): The variety and variability among living organisms and the ecological complexes in which they occur.

Boom (herbicide spray): A tubular metal device that conducts an herbicide mixture from a tank to a series of spray nozzles. It may be mounted beneath a helicopter or a fixed-wing aircraft, or behind a tractor or all-terrain vehicle.

Brackish: Saline water whose salt concentration is between that of freshwater and seawater (ranging from 0.5 to 30 parts per thousand).

Broadcast application: An application of an herbicide that uniformly covers an entire area.

Broad scale: A large, regional area, such as a river basin; typically a multi-state area.

Buffer: A solution or liquid whose chemical makeup is such that it minimizes changes in pH when acids or bases are added to it.

Buffer strip/zone: A strip of vegetation that is left or managed to reduce the impact that a treatment or action on one area might have on another area.

Bunchgrass: A grass having the characteristic growth habit of forming a bunch; lacking stolons or rhizomes.

C

California Puff (CALPUFF): CALPUFF is an advanced non-steady-state meteorological and air quality modeling system adopted by the U.S. Environmental Protection Agency as the preferred model for assessing long range transport of pollutants and their impacts involving complex meteorological conditions.

Carbon-14 dating: The use of the naturally occurring isotope of carbon-14 in radiometric dating to determine the age of organic materials.

Carcinogen: A chemical capable of inducing cancer.

Carnivore: An animal that feeds on other animals, especially the flesh-eating mammals.

Carrying capacity: The maximum population of a particular species that a particular region can support without hindering future generations' ability to maintain the same population.

Chaining: Vegetation removal that is accomplished by hooking a large anchor chain between two bulldozers; as the dozers move through the vegetation, the vegetation is knocked to the ground. Chaining kills a large percentage of the vegetation, and is often followed a year or two later by burning and/or seeding.

Chemical degradation: The breakdown of a chemical substance into simpler components through chemical reactions.

Chronic adverse effect level: The level at which a substance can cause adverse effects in which symptoms recur frequently or develop slowly over a long period of time.

Chronic exposure: Exposures that extend over the average lifetime or for a significant fraction of the lifetime of the individual. Chronic exposure studies are used to evaluate the carcinogenic potential of chemicals and other long-term health effects.

Class I area: Under the 1977 Clean Air Act amendments, all international parks, parks larger than 6,000 acres, and national wilderness areas larger than 5,000 acres that existed on August 7, 1977. This class provides the most protection to pristine lands by severely limiting the amount of additional air pollution that can be added to these areas.

Climate: The composite or generally prevailing weather conditions of a region throughout the year, averaged over a series of years.

Coarse woody debris: Pieces of woody material derived from tree limbs, boles, and roots in various stages of decay, generally having a diameter of at least 3 inches and a length greater than 3 feet.

Code of Federal Regulations (CFR): A codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the federal government.

Consultation: Exchange of information and interactive discussion; when the "C" in consultation is capitalized it refers to consultation mandated by statute or regulation that has prescribed parties, procedures, and timelines (e.g. Consultation under National Environmental Policy Act or Section 7 of the Endangered Species Act).

Council on Environmental Quality (CEQ): An advisory council to the President of the United States; established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

Countervailing: A type of cumulative impact where negative effects are compensated for by beneficial effects.

Cover: 1) Trees, shrubs, rocks, or other landscape features that allow an animal to partly or fully conceal itself. 2) The area of ground covered by plants of one or more species, usually expressed as a percent of the ground surface.

Criteria: Data and information that are used to examine or establish the relative degrees of desirability of alternatives or the degree to which a course of action meets an intended objective.

Criteria pollutants: Air pollutants designated by the U.S. Environmental Protection Agency as potentially harmful and for which ambient air quality standards have been set to protect the public health and welfare. The criteria pollutants are carbon monoxide, sulfur dioxide, particulate matter, nitrogen dioxide, ozone, hydrocarbons, and lead.

Critical habitat: 1) Specific areas within the habitat a species occupies at the time it is listed under the Endangered Species Act that have physical or biological features (a) that are essential to the conservation of the species and (b) that may require special management considerations or protection. 2) Specific areas outside the habitat a species occupies at the time it is listed that the Secretary of the Interior determines are essential for species conservation.

Cultural resources: Nonrenewable evidence of human occupation or activity as seen in any area, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature, which was important in human history at the national, state, or local level.

Cumulative effects: Impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over a period of time.

D

Degradation: Physical or biological breakdown of a complex compound into simpler compounds.

Density: The number of individuals per a given unit area.

Direct effects: Impacts on the environment that are caused by the action and occur at the same time and place.

Dispersion: The act of distributing or separating into lower concentrations or less dense units.

Disturbance: Refers to events that alter the structure, composition, or function of terrestrial or aquatic habitats. Natural disturbances include, among others, drought, floods, wind, fires, wildlife grazing, and insects and pathogens. Human-caused disturbances include actions such as timber harvest, livestock grazing, roads, and the introduction of exotic species.

Dominant: A group of plants that by their collective size, mass, or number exerts a primary influence onto other ecosystem components.

Dose: The amount of chemical administered or received by an organism, generally at a given point in time.

Draft Environmental Impact Statement (DEIS): The draft statement of the environmental effects of a major federal action which is required under Section 102 of the National Environmental Policy Act, and released to the public and other agencies for comment and review.

Drift: That part of a sprayed chemical that is moved by wind off a target site.

E

Ecosystem: Includes all the organisms of an area, their environment, and the linkages or interactions among all of them; all parts of an ecosystem are interrelated. The fundamental unit in ecology, containing both organisms and abiotic environments, each influencing the properties of the other and both necessary for the maintenance of life.

Ecosystem-based management: The use of an ecological approach to achieve multiple-use management of public lands by blending the needs of people and environmental values in such a way that public lands represent diverse, healthy, productive, and sustainable ecosystems.

Ecosystem health (forest health, rangeland health, aquatic system health): A condition where the parts and functions of an ecosystem are sustained over time and where the system's capacity for self-repair is maintained, such that goals for uses, values, and services of the ecosystem are met.

Ecotone: A boundary or zone of transition between adjacent communities or environments, such as the boundary between a forest and a meadow. Species present in an ecotone are intermixed subsets of the adjacent communities.

Edge effect: The influence of two communities on populations in their adjoining boundary zone or ecotone, affecting the composition and density of the populations in these bordering areas.

Effect: Environmental change resulting from a proposed action. Direct effects are caused by the action and occur at the same time and place, while indirect effects are caused by the action but are later in time or further removed in distance, although still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems. Effect and impact are synonymous as used in this document.

Endangered species: Plant or animal species that are in danger of extinction throughout all or a significant part of their range.

Endemic species: Plants or animals that occur naturally in a certain region and whose distribution is relatively limited to a particular locality.

Environment: 1) The physical conditions that exist within an area (e.g., the area that will be affected by a proposed project), including land, air, water, minerals, flora, fauna, ambient noise, and objects of historical or aesthetic significance; and 2) the sum of all external conditions that affect an organism or community to influence its development or existence.

Environmental Assessment (EA): A concise public document, for which a federal agency is responsible, that serves to: 1) briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact; 2) aid an agency's compliance with the National Environmental Policy Act when no environmental impact statement is necessary; and, 3) facilitate preparation of an environmental impact statement when one is necessary.

Environmental Impact Statement (EIS): A required report for all federal actions that will lead to significant effects on the quality of the human environment. The report must be systematic and interdisciplinary, integrating the natural and social sciences as well as the design arts in planning and decision-making. The report must identify 1) the environmental impacts of the proposed action, 2) any adverse environmental effects which cannot be avoided should the proposal be implemented, 3) alternatives to the proposed action, 4) the relationship between short-term uses of human environment and the maintenance and enhancement of long-term productivity, and 5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Eradication: Removal of all traces of a population or elimination of a population to the point where individuals are no longer detectable.

Erosion: The wearing away of the land surface by running water, wind, ice, gravity, or other geological activities; can be accelerated or intensified by human activities that reduce the stability of slopes or soils.

Essential Fish Habitat (EFH): As defined by Congress in the interim final rule (62FR 66551): "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." For the purpose of interpreting the definition of EFH habitat, "waters" include aquatic areas and their associated physical, chemical, and biological properties; "substrate" includes sediment underlying the waters; "necessary" refers to the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types utilized by a species throughout its life cycle.

Exotic species: Includes species introduced into an area that may have adapted to the area and compete with resident native (indigenous) species.

F

°F: Degrees Fahrenheit.

Fate: The course of an applied herbicide in an ecosystem or biological system, including metabolism, microbial degradation, leaching, and photodecomposition.

Fauna: The vertebrate and invertebrate animals of the area or region.

Feasible: Capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors.

Final Environmental Impact Statement (Final EIS): A revision of the Draft Environmental Impact Statement based on public and agency comments on the draft.

Fire dependent: An ecosystem evolving under periodic perturbations by fire and that consequently depends on periodic fires for normal ecosystem function.

Fire intolerant: Species of plants that do not grow well with or die from the effects of too much fire.

Fire regime: The patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects, in a given area or ecosystem.

Fire return interval: The average time between fires in a given area.

Fire tolerant: Species of plants that can withstand certain frequency and intensity of fire.

Fire use: The combination of prescribed fire and wildland fire usè for resource benefit to meet resource objectives.

Fisheries habitat: Streams, lakes, and reservoirs that support fish populations.

Fishery: The act, process, occupation, or season of taking an aquatic species.

Food Quality Protection Act (FQPA) safety factor: The Food Quality Protection Act safety factor is applied to pesticides that exhibit threshold effects to "take into account potential pre- and post-natal toxicity and completeness of the data with respect to exposure and toxicity to infants and children." The Act requires 1) an explicit determination that exposure tolerances are safe for children; 2) an additional safety factor of up to 10-fold, if necessary, be used to account for uncertainty in data relative to children (this is in addition to the current 100-fold safety factor which is already used to account for the use of animals, versus humans, in laboratory testing, and the variability in potential adult response to pesticide exposure); and 3) an analysis of exposure risks to children that takes into account the special sensitivity and exposure of children to pesticides.

Forage: Vegetation eaten by animals, especially grazing and browsing animals.

Forbs: Broad-leafed pants; includes plants that commonly are called weeds or wildflowers.

Forestland: Land where the potential natural plant community contains 10% or more tree canopy cover.

Formulation: The commercial mixture of both active and inactive (inert) ingredients.

Fossilization: The process of fossilizing a plant or animal that existed in some earlier age; the process of being turned to stone.

Fragmentation (habitat): The breaking-up of a habitat or cover type into smaller, disconnected parcels.

Fuel (fire): Dry, dead parts of trees, shrubs, and other vegetation that can burn readily.

G

Groundwater: Subsurface water that is in the zone of saturation. The top surface of the groundwater is the "water table." Source of water for wells, seeps, and springs.

H

Habitat: The natural environment of a plant or animal, including all biotic, climatic, and soil conditions, or other environmental influences affecting living conditions. The place where an organism lives.

Habitat fragmentation: The break-up of a large land area (such as forest) into smaller patches isolated by areas converted to a different land type. The opposite of connectivity.

Half life: The amount of time required for half of a compound to degrade.

Hazardous fuels: Includes living and dead and decaying vegetation that form a special threat of ignition and resistance to control.

Hazard quotient (HQ): The ratio of the estimated level of exposure to a substance from a specific substance from a specific pesticide application to the reference dose (RfD) for that substance, or to some other index of acceptable exposure or toxicity. A HQ less than or equal to 1 is presumed to indicate an acceptably low level of risk for that specific application.

Herbaceous: Non-woody plants that include grasses, grass-like plants, and forbs.

Herbicide: A chemical pesticide used to control, suppress, or kill vegetation, or severely interrupt normal growth processes.

Herbicide resistance: Naturally occurring heritable characteristics that allow individual weeds to survive and reproduce, producing a population, over time, in which the majority of the plants of the weed species have the resistant characteristics.

Herbivore: An animal that feeds on plants.

Herd Management Areas (HMAs): Areas established for wild and free-roaming horses and burros through the land use planning process. The Wild Free-roaming Horse and Burro Act of 1971 requires that wild free-roaming horses and burros be considered for management where they were found at the time Congress passed the Act. The BLM initially identified 264 areas of use as herd management areas.

Historical range of variability (HRV): The natural fluctuation of ecological and physical processes and functions that would have occurred in an ecosystem during a specified previous period. In this PER, refers to the range of conditions that are likely to have occurred for several centuries prior to settlement of the project area by people of European descent (approximately the mid-1800s), which would have varied within certain limits over time. HRV is discussed only as a reference point, to establish a baseline set of conditions for which sufficient scientific or historical information is available to enable comparison to current conditions.

Home range: The area around an animal's established home that is visited during the animal's normal activities.

Hydrologic cycle (water cycle): The ecological cycle that moves water from the air by precipitation to the earth and returns it to the atmosphere; includes evaporation, run-off, infiltration, percolation, storage, and transpiration.

Hydrologic unit code (HUC): A hierarchical coding system developed by the U.S. Geological Survey to identify geographic boundaries of watersheds of various sizes.

Hydrolysis: Decomposition or alteration of a chemical substance by water.

I

Impermeable: Cannot be penetrated.

Indigenous: Living or occurring naturally in an area; native, endemic people, flora, or fauna.

Indirect effects: Impacts that are caused by an action, but are later in time or farther removed in distance, although still reasonably foreseeable.

Inert ingredient(s): Those ingredients that are added to the commercial product (formulation) and are not herbicidally active.

Infiltration: The movement of water through soil pores and spaces.

Insectivore: An organism that feeds mainly on insects.

Integrated pest management (IPM): A long-standing, science-based, decision-making process that identifies and reduces risks from pests and pest management related strategies. It coordinates the use of pest biology, environmental information, and available technology to prevent unacceptable levels of pest damage by the most economical means, while posing the least possible risk to people, property, resources, and the environment. IPM provides an effective strategy for managing pests in all arenas from developed agricultural, residential, and public areas to wild lands. IPM serves as an umbrella to provide an effective, all encompassing, low-risk approach to protect resources and people from pests. BLM Departmental Manual 517 (Pesticides) defines integrated pest management as "a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks."

Intermittent stream: A stream that flows only a certain times of the year when it receives water from other streams or from surface sources such as melting snow.

Invasive plants: Plants that 1) are not part of (if exotic), or are a minor component of (if native), the original plant community or communities; 2) have the potential to become a dominant or co-dominant species on the site if their future establishment and growth is not actively controlled by management interventions; or 3) are classified as exotic or noxious plants under state or federal law. Species that become dominant for only one to several years (e.g. short-term response to drought or wildfire) are not invasive plants.

Invasive species: Per Executive Order 13112, an invasive species means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.

Invertebrate: Small animals that lack a backbone or spinal column. Spiders, insects, and worms are examples of invertebrates.

Irretrievable commitment: A term that applies to losses of production or commitment of renewable natural resources. For example, while an area is used as a ski area, some or all of the timber production there is "irretrievably" lost. If the ski area closes, timber production could resume; therefore, the loss of timber production during the time the area is devoted to skiing is irretrievable, but not irreversible, because it is possible for timber production to resume if the area is no longer used as a ski area.

Irreversible commitment: A term that applies to non-renewable resources, such as minerals and archaeological sites. Losses of these resources cannot be reversed. Irreversible effects can also refer to the effects of actions on resources that can be renewed only after a very long period of time, such as the loss of soil productivity.

Issue: A matter of controversy, dispute, or general concern over resource management activities or land uses.

J

K

K_{oc}: Organic carbon-water partition coefficient.

L

LC_{50} (median lethal concentration): A calculated concentration of a chemical in air or water to which exposure for a specific length of time is expected to cause death in 50 percent of a defined experimental animal population.

LD_{50} (median lethal dose): The dose of a chemical calculated to cause death in 50% of a defined experimental animal population over a specified observation period. The observation period is typically 14 days.

Land management: The intentional process of planning, organizing, programming, coordinating, directing, and controlling land use actions.

Landscape: All the natural features such as grasslands, hills, forest, and water, which distinguish one part of the earth's surface from another part; usually that portion of land that the eye can comprehend in a single view, including all of its natural characteristics.

Land use allocation: The assignment of a management emphasis to particular land areas with the purpose of achieving the goals and objectives of some specified use(s) (e.g., campgrounds, wilderness, logging, and mining).

Large woody debris: Pieces of wood that are of a large enough size to affect stream channel morphology.

Leaching: Usually refers to the movement of chemicals through the soil by water; may also refer to the movement of herbicides out of leaves, stems, or roots into the air or soil.

Level of concern (LOC): The concentration in media or some other estimate of exposure above which there may be effects.

Lichens: Organisms made up of specific algae and fungi, forming identifiable crusts on soil, rocks, tree, bark, and other surfaces. Lichens are primary producers in ecosystems. They contribute living material and nutrients, enrich the soil and increase soil moisture-holding capacity, and serve as food sources for certain animals. Lichens are slow growing and sensitive to chemical and physical disturbances.

Lifeways: The manner and means by which a group of people lives; their way of life. Components include language(s), subsistence strategies, religion, economic structure, physical mannerisms, and shared attitudes.

Litter: The uppermost layer of organic debris on the soil surface, which is essentially the freshly fallen or slightly decomposed vegetation material such as stems, leaves, twigs, and fruits.

Long term: Generally refers to a period longer than 10 years.

M

Macrophytes: Terrestrial or aquatic plants that are large enough to be seen without the aid of a microscope.

Material safety data sheet (MSDS): a compilation of information required under the OSHA Communication Standard on the identity of hazardous chemicals, health and physical hazards, exposure limits, and precautions.

Memorandum of Understanding (MOU): Usually documents an agreement reached amongst federal agencies.

Microbial degradation: The breakdown of a chemical substance into simpler components by bacteria or other microorganisms.

Microbiotic crust: See biological crust.

Minimize: Apply best available technology, management practices, and scientific knowledge to reduce the magnitude, extent, and/or duration of impacts.

Minimum tool rule: Apply only the minimum-impact policy, device, force, regulation, instrument, or practice to bring about a desired result.

Mitigation: Steps taken to: 1) avoid an impact altogether by not taking a certain action or parts of an action; 2) minimize an impact by limiting the degree or magnitude of the action and its implementation; 3) rectify an impact by repairing, rehabilitating, or restoring the affected environment; 4) reduce or eliminate an impact over time by preserving and maintaining operations during the life of the action; and, 5) compensate for an impact by replacing or providing substitute resources or environments (40 CFR Part 1508.20).

Mitigation measures: Means taken to avoid, compensate for, rectify, or reduce the potential adverse impact of an action.

Monitoring: The orderly collection, analysis, and interpretation of resource data to evaluate progress toward meeting management objectives.

Multiple uses: A combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources. These may include recreation, range, timber, minerals, watershed, wildlife, and fish, along with natural scenic, scientific, and historical values.

N

National Ambient Air Quality Standards (NAAQS): Standards set by the Environmental Protection Agency for the maximum levels of pollutants that can exist in the outdoor air without unacceptable effects on human health or the public welfare.

National Back Country Byways: A program developed by the BLM to complement the National Scenic Byway program. The Bureau of Land Management's Byways show enthusiasts the best the West has to offer—from waterfalls to geology sculpted by volcanoes, glaciers, and rivers. Back Country Byways vary from narrow, graded roads, passable only during a few months of the year, to two-lane paved highways providing year-round access.

National Conservation Areas: Areas designated by Congress so that present and future generations of Americans can benefit from the conservation, protection, enhancement, use, and management of these areas by enjoying their natural, recreational, cultural, wildlife, aquatic, archeological, paleontological, historical, educational, and/or scientific resources and values.

National Environmental Policy Act (NEPA): An act of Congress passed in 1969, declaring a national policy to encourage productive and enjoyable harmony between people and the environment, to promote efforts that will prevent or eliminate damage to the environment and the biosphere and stimulate the health and welfare of people, and to enrich the understanding of the ecological systems and natural resources important to the nation, among other purposes.

National Historic Trails: Trails established to identify and protect historic routes; they follow as closely as possible the original trails or routes of travel of national historic significance.

National Landscape Conservation System (NLCS): A single system that encompasses some of the BLM's premier land designations. By putting these lands into an organized system, the BLM hopes to increase public awareness of these areas' scientific, cultural, educational, ecological, and other values.

National Monument: An area designated to protect objects of scientific and historic interest by public proclamation of the President under the Antiquities Act of 1906, or by the Congress for historic landmarks, historic and prehistoric structures, or other objects of historic or scientific interest situated upon the public lands: designation also provides for the management of these features and values.

National Recreation Area: An area designated by Congress to assure the conservation and protection of natural, scenic, historic, pastoral, and fish and wildlife values and to provide for the enhancement of recreational values.

National Recreation Trails: Trails established administratively by the Secretary of the Interior to provide for a variety of outdoor recreation uses in or reasonably close to urban areas. They often serve as connecting links between the National Historic Trails and National Scenic Trails.

National Scenic Areas: Refers to the one national scenic area managed by the BLM: The Santa Rosa Mountains National Scenic Area in California, which encompasses approximately 101,000 acres. This area was designated by the Secretary of the Interior in 1990 to provide for the conservation, protection, and enhancement of scenic, recreation, and pastoral values.

National Scenic Trails: Trails established by an Act of Congress that are intended to provide for maximum outdoor recreation potential and for the conservation and enjoyment of nationally significant scenic, historical, natural, and cultural qualities of the areas through which these trails pass. National Scenic Trails may be located to represent desert, marsh, grassland, mountain, canyon, river, forest, and other areas, as well as land forms that exhibit significant characteristics of the physiographic regions of the nation.

National Wild and Scenic Rivers: Rivers designated in the National Wild and Scenic Rivers System that are classified in one of three categories, depending on the extent of development and accessibility along each section. In addition to being free flowing, these rivers and their immediate environments must possess at least one outstandingly remarkable value: scenic, recreational, geologic, fish and wildlife, historical, cultural, or other similar values.

Native species: Species that historically occurred or currently occur in a particular ecosystem and were not introduced.

Natural community: An assemblage of organisms indigenous to an area that is characterized by distinct combinations of species occupying a common ecological zone and interacting with one another.

Natural resources: Water, soil, plants and animals, nutrients, and other resources produced by the earth's natural processes.

No action alternative: The most likely condition to exist in the future if current management direction were to continue unchanged.

No observed adverse effect level (NOAEL): The exposure level at which there are no statistically or biological significant differences in the frequency or severity of any adverse effect in the exposed or control populations.

Non-target: Any plant, animal, or organism that a method of application is not aimed at, but may accidentally be injured by the application.

Non-selective herbicide: An herbicide that is generally toxic to plants without regard to species or type.

Noxious weed: A plant species designated by federal or state law as generally possessing one or more of the following characteristics: aggressive and difficult to manage; parasitic; a carrier or host of serious insects or disease; or non-native, new, or not common to the United States.

Nutrient cycle: Ecological processes in which nutrients and elements such as carbon, phosphorous, nitrogen, and others, circulate among animals, plants, soils, and air.

O

Objective: A concise, time-specific statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used to achieve identified goals.

Omnivore: An animal that eats a combination of meat and vegetation.

Oregon and California lands: Public lands in Western Oregon that were granted to the Oregon Central Railroad companies (later the Oregon and California Railroad Company) to aid in the construction of railroads, but that were later forfeited and returned to the federal government by revestment of title.

Overgrazing: Continued heavy grazing which exceeds the recovery capacity of the plant community and creates a deteriorated rangeland.

Overstory: The upper canopy layer.

P

Paleontological resources: A work of nature consisting of or containing evidence of extinct multicellular beings and includes those works or classes of works of nature designated by the regulations as paleontological resources.

Paleontology: A science dealing with the life of past geological periods as known from fossil remains.

Particulate matter (PM): A complex mixture consisting of varying combinations of dry solid fragments, solid cores with liquid coatings, and small droplets of liquid. These tiny particles vary greatly in shape, size and chemical composition, and can be made up of many different materials such as metals, soot, soil and dust.

Particulates: Solid particles or liquid droplets suspended or carried in the air.

Pathogen: An agent such as a fungus, virus, or bacterium that causes disease.

Payments in lieu of taxes: Payments made to counties by the BLM to mitigate for losses to counties because public lands cannot be taxed.

Per capita income: Total income divided by the total population.

Perennial: A plant that lives for 2 or more years.

Permit: A revocable authorization to use public land for a specified purpose to for up to 3 years.

Persistence: Refers to the length of time a compound, once introduced into the environment, stays there.

Pest Infestation: 1) The occurrence of one or more pest species in an area or location where their numbers and impact are currently or potentially at intolerable levels. 2) A sudden increase in destructiveness or population numbers of a pest species in a given area.

Petroglyph: An image recorded on stone, usually by prehistoric peoples, by means of carving, pecking, or otherwise incised on natural rock surfaces.

Pictograph: A symbol that represents an object or a concept by illustration.

pH: A measure of how acidic or alkaline (basic) a solution is on a scale of 0 to 14 with 0 being very acidic, 14 being very alkaline, and 7 being neutral. The abbreviation stands for the potential of hydrogen.

Photodegradation: The photochemical transformation of a molecule into lower molecular weight fragments, usually in an oxidation process. This term is widely used in the destruction (oxidation) of pollutants by UV-based processes.

Photolysis: Chemical decomposition induced by light or other radiant energy.

Phytotoxicity: The ability of a material such as a pesticide or fertilizer to cause injury to plants.

Piscivore: Animal that feeds on fish.

Plant community: A vegetation complex, unique in its combination of plants, which occurs in particular locations under particular influences. A plant community is a reflection of integrated environmental influences on the site, such as soils, temperature, elevation, solar radiation, slope aspect, and precipitation.

Playas: Flat land surfaces underlain by fine sediment or evaporate minerals deposited from a shallow lake on the floor of a topographic depression.

$PM_{2.5}$: Fine particulates that measure 2.5 microns in diameter or less.

PM_{10}: Particulate matter that measures 10 microns in diameter or less.

Porosity: The ratio of the volume of void space in a material (e.g., sedimentary rock or sediments) to the volume of its mass.

Predator: An organism that captures and feeds on parts or all of a living organism of another species.

Preferred alternative: The alternative identified in an EIS that has been selected by the agency as the most acceptable resolution to the problems identified in the purpose and need.

Prescribed fire: A management ignited wildland fire that burns under specified conditions and in predetermined area, and that produces the fire behavior and fire characteristics required to attain fire treatment and resource management objectives.

Prescribed fire projects: Includes the BLM's efforts to utilize fire as a critical natural process to maintain and restore ecosystems, rangeland, and forest lands, and to reduce the hazardous buildup of fuels that may threaten healthy lands and public safety.

Prescribed grazing: The careful application of grazing or browsing prescriptions (i.e., specified grazing intensities, seasons, frequencies, livestock species, and degrees of selectivity) to achieve natural resource objectives. Livestock production is a secondary objective when using prescribed grazing as a natural resource management tool.

Prevention of Significant Deterioration (PSD): A U.S. Environmental Protection Agency program in which state and/or federal permits are required in order to restrict emissions from new or modified sources in places where air quality already meets or exceeds primary and secondary ambient air quality standards.

Productivity: The innate capacity of an environment to support plant and animal life over time. Plant productivity is the rate of plant production within a given period of time. Soil productivity is the capacity of a soil to produce plant growth, due to the soil's chemical, physical, and biological properties.

Programmatic EIS: An area-wide EIS that provides an overview when a large-scale plan is being prepared for the management of federally-administered lands on a regional or multi-regional basis.

Proper functioning condition: Riparian and wetland areas achieve proper functioning condition when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high water flows. This reduces erosion and improves water quality; filters sediment, captures bedload, and aids in floodplain development; improves floodwater retention and groundwater recharge; develops root masses that stabilize streambacks against cutting; develops diverse ponding and channel characteristics to provide habitat and water depth, duration, and temperature necessary for fish production, avian breeding habitat, and other uses; and support greater biodiversity.

Proposed action: A proposal by a federal agency to authorize, recommend, or implement an action.

Public domain lands: One category of public lands that have never left federal ownership; also, lands in federal ownership that were obtained by the government in exchange for public domain lands or for timber on public domain lands.

Public lands: Any land and interest in land owned by the United States that are administered by the Secretary of the Interior through the BLM, without regard to how the United States acquired ownership, except for (1) lands located on the Outer Continental Shelf, and (2) lands held for the benefit of Indians, Aleuts, and Eskimos. Includes public domain and acquired lands.

Public scoping: A process whereby the public is given the opportunity to provide oral or written comments about the influence of a project on an individual, the community, and/or the environment.

Q

Qualitative: Traits or characteristics that relate to quality and cannot be readily measured with numbers.

Quantitative: Traits or characteristics that can be measured with numbers.

R

Rangeland: Land on which the native vegetation is predominantly grasses, grass-like plants, forbs, or shrubs; not forests.

Raptor: Bird of prey; includes eagles, hawks, falcons, and owls.

Receptor: An ecological entity exposed to a stressor.

Record of Decision (ROD): A document separate from, but associated with, an EIS, which states the decision, identifies alternatives (specifying which were environmentally preferable), and states whether all practicable means to avoid environmental harm from the alternative have been adopted, and if not, why not.

Recovery plan: Identifies, justifies, and schedules the research and management actions necessary to reverse the decline of a species and ensure its long-term survival.

Reference dose (RfD): An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to not result in an appreciable risk of deleterious effects during a lifetime. It is derived from the no-observed-adverse-effect-level, the lowest-observed-adverse-effect-level, or a benchmark dose. Uncertainty factors are generally applied when developing the reference dose to reflect the limitations of the data used.

Registered herbicide: All herbicides sold or distributed in the United States must be registered by the U.S. Environmental Protection Agency, based on scientific studies, showing that they can be used without posing unreasonable risks to people or the environment.

Research Natural Areas: Special management areas designated either by Congress or by a public or private agency to preserve and protect typical or unusual ecological communities, associations, phenomena, characteristics, or natural features or processes for scientific and educational purposes. They are established and managed to protect ecological processes, conserve biological diversity, and provide opportunities for observation for research and education.

Resident fish: Fish that spend their entire life in freshwater (e.g., bull trout).

Residue: The quantity of an herbicide or its metabolites remaining in or on soil, water, plants, animals, or surfaces.

Resource Management Plan (RMP): Comprehensive land management planning document prepared by and for the BLM's administered properties under requirements of the Federal Land Policy and Management Act. Bureau of Land Management lands in Alaska were exempted from this requirement.

Restoration: Actions taken to modify an ecosystem to achieve desired, healthy, and functioning conditions and processes.

Revegetation: Establishing or re-establishing desirable plants on areas where desirable plants are absent or of inadequate density, by management alone (natural revegetation) or by seeding or transplanting (artificial revegetation).

Rights-of-way (ROW): A permit or an easement that authorizes the use of lands for certain specified purposes, such as the construction of forest access roads or a gas pipeline.

Riparian: Occurring adjacent to streams and rivers and directly influenced by water. A riparian community is characterized by certain types of vegetation, soils, hydrology, and fauna and requires free or unbound water or conditions more moist than that normally found in the area.

Risk: The likelihood that a given exposure to an item or substance that presents a certain hazard will produce illness or injury.

Risk assessment: The process of gathering data and making assumptions to estimate short- and long-term harmful effects on human health or the environment from particular products or activities.

Runoff: That part of precipitation, as well as any other flow contributions, that appears in surface streams, either perennial or intermittent.

S

Salmonids: Fishes of the family Salmonidae, including salmon, trout, chars, whitefish, ciscoes, and grayling.

Scoping: The process by which significant issues relating to a proposal are identified for environmental analysis. Scoping includes eliciting public comment on the proposal, evaluating concerns, and developing alternatives for consideration.

Section 3: Lands administered under Section 3 of the Taylor Grazing Act. This section of the law provided for the lease of grazing district lands to landowners and homesteaders in or adjacent to the reserves first and issuance of 1 to 10 year leases.

Section 15: Lands administered under Section 15 of the Taylor Grazing Act. Under Section 15, public lands outside of grazing districts could be leased to ranchers with contiguous property.

Sediments: Unweathered geologic materials generally laid down by or within waterbodies; the rocks, sand, mud, silt, and clay at the bottom and along the edge of lakes, streams, and oceans.

Sedimentation: The process of forming or depositing sediment; letting solids settle out of wastewater by gravity during treatment.

Selective herbicide: A chemical designed to affect only certain types of plants, leaving other plants unharmed.

Semi-arid: Moderately dry; region or climate where moisture is normally greater than under arid conditions, but still limits the production of vegetation.

Sensitive species: 1) Plant or animal species susceptible or vulnerable to activity impacts or habitat alterations. 2) Species that have appeared in the Federal Register as proposed for classification or are under consideration for official listing as endangered or threatened species.

Seral: Refers to the stages that plant communities go through during succession. Developmental stages have characteristic structure and plant species composition. In a forest, for example, early seral forest refers to seedling or sapling growth stages; mid sera refers to pole or medium saw timber growth stages; and mature or late seral forest refers to mature and old-growth stages.

Shade-intolerant: Species of plant that need full sunlight to grow in the shade. Generally, these are more fire-adapted species.

Shade-tolerant species: Species of plants that can establish and grow in the shade. Generally, these are more fire-sensitive species.

Short-term impacts: Impacts occurring during project construction and operation, and normally ceasing upon project closure and reclamation. For each resource the definition of short-term may vary.

Significant: The description of an impact that exceeds a certain threshold level. Requires consideration of both context and intensity. The significance of an action must be analyzed in several contexts, such as society as a whole, and the affected region, interests, and locality. Intensity refers to the severity of impacts, which should weighted along with the likelihood of its occurrence.

Snag: A standing dead tree, usually larger than 5 feet tall and 6 inches in diameter at breast height.

Sociocultural: Of, relating to, or involving a combination of social and cultural factors.

Socioeconomic: Pertaining to, or signifying the combination or interaction of social and economic factors.

Soil compaction: The compression of the soil profile from surface pressure, resulting in reduced air space, lower water holding capacity, and decreased plant root penetrability.

Soil horizon: A layer of soil material approximately parallel to the land surface that differs from adjacent, genetically related, layers in physical, chemical, and biological properties.

Southern Nevada Public Land Management Act: Act that provides for the disposal of public land within a specific area in the Las Vegas Valley and creates a special account into which 85% of the revenue generated by land sales or exchanges in the Las Vegas Valley is deposited. The remaining 15% goes to state and local governments.

Special status species: Refers to federally-listed threatened, endangered, proposed, or candidate species, and species managed as sensitive species by the BLM.

Spot treatment: An application of an herbicide to a small selected area as opposed to broadcast application.

Stabilizer: A type of inert ingredient added to a commercial pesticide that makes the mixture more stable.

Stand: A group of trees in a specific area that is sufficiently alike in composition, age, arrangement, and condition so as to be distinguishable from the forest in adjoining areas.

Standard Operating Procedures (SOPs): Procedures that would be followed by the BLM to ensure those risks to human health and the environment from treatment actions were kept to a minimum.

Step-down: Refers to the process of applying broad-scale science findings and land use decisions to site-specific areas using a hierarchical approach of understanding current resource conditions, risks, and opportunities.

Subalpine: A terrestrial community that generally is found in harsher environments than the montane terrestrial community. Subalpine communities are generally colder than montane and support a unique clustering of wildlife species.

Subchronic: The effects observed from doses that are of intermediate duration, usually 90 days.

Subsistence: Customary and traditional uses of wild renewable resources (plants and animals) for food, shelter, fuel, clothing, tools, etc.

Succession: A predictable process of changes in structure and composition of plant and animal communities over time. Conditions of the prior plant community or successional stage create conditions that are favorable for the establishment of the next stage. The different stages in succession are often referred to as seral stages.

Surfactant: A material that improves the emulsifying, dispersing, spreading, wetting, or other surface-modifying properties of liquids.

Surrogate: A substitute or stand-in.

Synergistic: A type of cumulative impact where total effect is greater than the sum of the effects taken independently.

T

Target species: Plant species of competing vegetation that is controlled in favor of desired species.

Terrestrial: Of or relating to the earth, soil, or land; inhabiting the earth or land.

Threatened species: A plant or animal species likely to become an endangered species throughout all or a significant portion of its range within the foreseeable future.

Threshold: A dose or exposure below which there is no apparent or measurable adverse effect.

Tier: In an EIS, refers to incorporating by reference the analyses in an EIS or similar document of a broader scope. For example, BLM field offices could prepare environmental assessments for local projects that tier to this PEIS.

Total suspended particles (TSP): A method of monitoring airborne particulate matter by total weight.

Toxicity: A characteristic of a substance that makes it poisonous.

Transpiration: Water loss from plants during photosynthesis.

Tribe: Term used to designate any Indian tribe, band, nation, or other organized group or community (including any Alaska Native village or regional or village corporation as defined in or established pursuant to the Alaska Native Claims Settlement Act) which is recognized as eligible for the special programs and services provided by the U.S. to Indians because of their status as Indians.

U

Understory: Plants that grow beneath the canopy of other plants. Usually refers to grasses, forbs, and low shrubs under a tree or shrub canopy.

Undesirable plants: Species classified as undesirable, noxious, harmful, exotic, injurious, or poisonous under state or federal law, but not including species listed as endangered by the Endangered Species Act, or species indigenous to the planning area.

Upland: The portion of the landscape above the valley floor or stream.

V

Vascular plants: Plants that have specialized tissues which conduct nutrients, water, and sugars along with other specialized parts such as roots, stems, and reproductive structures. Vascular plants include flowering plants, ferns, shrubs, grasses, and trees.

Vertebrate: An animal with a backbone. Fishes, amphibians, reptiles, birds, and mammals are vertebrates.

Visual resources: The visible physical features of a landscape.

Volatilization: The conversion of a solid or liquid into a gas or vapor.

W

Water quality: The interaction between various parameters that determines the usability or non-usability of water for on-site and downstream uses. Major parameters that affect water quality include: temperature, turbidity, suspended sediment, conductivity, dissolved oxygen, pH, specific ions, discharge, and fecal coliform.

Watershed: The region draining into a river, river system, or body of water.

Weed: A plant considered undesirable and that interferes with management objectives for a given area at a given point in time.

Wetlands: Those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include habitats such as swamps, marshes, and bogs.

Wilderness: Land designated by Congress as a component of the National Wilderness Preservation System. For an area to be considered for Wilderness designation it must be roadless and possess the characteristics required by Section 2(c) of the Wilderness Act of 1964. These characteristics are: 1) naturalness - lands that are natural and primarily affected by the forces of nature; 2) roadless and having at least 5,000 acres of contiguous public lands; and 3) outstanding opportunities for solitude or a primitive and unconfined types of recreation. In addition, areas may contain "supplemental values," consisting of ecological, geological, or other features of scientific, educational, scenic, or historical importance.

Wildfire: Unplanned human or naturally caused fires in wildlands.

Wildland fires: Occur on wildlands, regardless of ignition source, damages, or benefits, and include wildfire and prescribed fire.

Wildland fire use for resource benefit: A fire ignited by lightening, but allowed to burn within specified conditions of fuels, weather, and topography, to achieve specific objectives.

Wildland Urban Interface (WUI): An area where structures and other human development intermingle with undeveloped wildlands or vegetative fuels.

Woodland: A forest in which the trees are often small, characteristically short-bolded relative to their crown depth, and forming only an open canopy with the intervening area being occupied by lower vegetation, commonly grass.

X

Xeric: Very dry region or climate; tolerating or adapted to dry conditions.

YZ

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APPENDIX A

COMMON AND SCIENTIFIC NAMES OF PLANTS AND ANIMALS GIVEN IN THE PROGRAMMATIC ENVIRONMENTAL REPORT

APPENDIX A

COMMON AND SCIENTIFIC NAMES OF PLANTS AND ANIMALS GIVEN IN THE PROGRAMMATIC ENVIRONMENTAL REPORT

This appendix contains a list of the common and scientific names of plant and animal species mentioned in the text of the Programmatic Environmental Report.

Common Name	Scientific Name
PLANTS	
Grasses	
Barley, Wild	*Hordeum spontaneum*
Beachgrass, European	*Ammophila arenaria*
Bentgrass	*Agrostis* spp.
Bermudagrass	*Cynodon dactylon*
Bluegrass	*Poa* spp.
Bluegrass, Annual	*Poa annua*
Bluegrass, Kentucky	*Poa pratensis*
Bluegrass, Sandberg	*Poa secunda*
Bluejoint	*Calamagrostis canadensis*
Bluestem	*Andropogon* spp.
Bluestem, Cane	*Bothriochloa barbinodis*
Brome	*Bromus* spp.
Brome, Downy	*Bromus tectorum*
Brome, Foxtail	*Bromus rubens*
Brome, Japanese	*Bromus japonicus*
Brome, Red	*Bromus rubens*
Brome, Ripgut	*Bromus diandrus*
Brome, Smooth	*Bromus inermis*
Brome, Soft	*Bromus hordeaceus*
Buffalograss	*Bouteloua dactyloides*
Buffelgrass	*Pennisetum ciliare*
Bulrush	*Scirpus* spp.
Bulrush, River	*Schoenoplectus fluviatilis*
Bunchgrass	*Agropyron* spp.
Canarygrass, Reed	*Phalaris arundinacea*
Cheatgrass	*Bromus tectorum*
Cogongrass	*Imperata cylindrica*
Cordgrass	*Spartina* spp.
Corn (Maize)	*Zea mays*
Cottongrass	*Eriophorum* spp.
Cottongrass, Tussock	*Eriophorum vaginatum*
Dunegrass, American	*Leymus mollis*
Fescue	*Festuca* spp.

Common Name	Scientific Name
PLANTS (Cont.)	
Fescue, Idaho	*Festuca idahoensis*
Fescue, Rough	*Festuca campestris*
Galleta, James'	*Pleuraphis jamesii*
Goatgrass, Barbed	*Aegilops triuncialis*
Grama, Black	*Bouteloua eriopoda*
Grama, Blue	*Bouteloua gracilis*
Grama, Hairy	*Bouteloua hirsute*
Grama, Sideoats	*Bouteloua curtipendula*
Grass, Common Mediterranean	*Schismus barbatus*
Grass, Giant Reed	*Phragmites australis*
Grass, Needle-and-thread	*Hesperostipa comata*
Hairgrass	*Aria* spp.
Junegrass	*Koeleria* spp.
Johnsongrass	*Sorghum halepense*
Lovegrass	*Eragrostis* spp.
Lovegrass, Plains	*Eragrostis intermedia*
Medusahead	*Taeniatherum caput-medusae*
Mesquite, Curly-	*Hilaria belangeri*
Mesquite, Vine	*Panicum obtusum*
Muhly, Bush	*Muhlenbergia porteri*
Needlegrass	*Achnatherum* spp.
Needlegrass, Purple	*Nassella pulchra*
Oat, Slender	*Avena barbata*
Oat, Wild	*Avena fatua*
Oatgrass	*Danthonia* spp.
Quackgrass	*Elymus repens*
Pappusgrass	*Pappophorum* spp.
Reed	*Phragmites* spp.
Reed, Common (Phragmites)	*Phragmites australis*
Reed, Giant	*Arundo donax*
Reedgrass	*Calamagrostis* spp.
Ricegrass, Indian	*Oryzopsis hymenoides*
Ryegrass	*Lolium* spp.
Sacaton	*Sporobolus* spp.
Saltgrass	*Distichlis spicata*
Squirreltail	*Elymus elymoides*
Sweetgrass	*Hierochloe* spp.
Tanglehead	*Heteropogon contortus*
Threeawn	*Aristida* spp.
Threeawn, Prairie	*Aristida oligantha*
Tobosagrass	*Pleuraphis mutica*
Tussock, Sedge	*Carex stricta*
Wheatgrass, Bluebunch	*Agropyron spicata*
Wheatgrass, Crested	*Agropyron cristatum*
Wheatgrass, Western	*Agropyron smithii*
Wildrye, Basin	*Elymus cinereus*
Wolfstail	*Lycurus setosus*
Forbs and Nonvascular Plants	
Amaranth	*Amaranthus* spp.
Angelica	*Angelica* spp.

Common Name	Scientific Name
PLANTS (Cont.)	
Arrowweed	*Pluchea sericea*
Artichoke, Jerusalem	*Helianthus tuberosus*
Avens, Mountain	*Dryas octopetala*
Balsamroot	*Balsamorhiza* spp.
Beargrass, Common	*Xerophyllum tenax*
Bindweed, Field	*Convolvulus arvensis*
Bitteroot	*Lewisia* spp.
Blazingstar	*Mentzelia* spp.
Brackenfern	*Pteridium aquilinum*
Burclover	*Medicago polymorpha*
Burningbush	*Bassia scoparia*
Camas	*Camassia* spp.
Campion, Moss	*Silene acaulis*
Cattail	*Typha* spp.
Celery, Wild	*Apium graveolens*
Cinquefoil	*Potentilla* spp.
Cinquefoil, Shrubby	*Dasiphora fruticosa* ssp. *floribunda*
Clover	*Trifolium* spp.
Clover, Thompson's	*Trifolium thompsonii*
Cocklebur	*Xanthium* spp.
Cotton	*Gossypium* spp.
Cress, Hoary	*Cardaria draba*
Dock	*Rumex* spp.
Dogbane	*Apocynum* spp.
Dove Weed	*Croton setigerus*
Filaree, Broadstem (Longbeak Stork's Bill)	*Erodium botrys*
Filaree, Redstem (Redstem Stork's Bill)	*Erodium cicutarium*
Fireweed	*Epilobium angustifolium*
Ginseng	*Eleutherococcus pentaphyllus*
Goldenseal	*Hydrastis canadensis*
Halogeton (Saltlover)	*Halogeton glomeratus*
Heath	*Erica* spp.
Hogfennel	*Peucedanum praeruptorum*
Horehound	*Ballota* spp.
Horsetail	*Equisetum* spp.
Houndstongue	*Cynoglossum officinale*
Hyacinth, Water	*Eichhornia crassipes*
Ivy, Poison	*Toxicodendron radicans*
Jacob's-ladder	*Polemonium* spp.
Jimsonweed	*Datura stramonium*
Kelp, Bull	*Nereocystis luetkeana*
Knapweed, Diffuse	*Centaurea diffusa*
Knapweed, Russian	*Centaurea repens*
Knapweed, Spotted	*Centaurea stoebe*
Knapweed, Squarrose	*Centaurea virgata*
Knapweed, Tyrol	*Centaurea nigrescens*
Knotweed, Japanese	*Polygonum cuspidatum*
Lily	Liliaceae
Lily, Sego	*Calochortus nuttallii*
Liverwort	*Marchantia polymorpha*

Common Name	Scientific Name
PLANTS (Cont.)	
Lomatium	*Lomatium* spp.
Loosestrife, Purple	*Lythrum salicaria*
Lupine	*Lupinus* spp.
Milkweed	*Asclepias* spp.
Milkweed, Whorled	*Asclepias verticillata*
Moss, Feather	*Ptilium crista-castrensis*
Moss, Sphagnum	*Sphagnum cymbifolium*
Mullein	*Verbascum* spp.
Mustard, Wild	*Sinapis arvensis*
Nettle, Stinging	*Urtica dioica*
Onion, Wild	*Allium ascalonicum*
Parsnip, Wild	*Pastinaca sativa*
Pepperweed, Perennial	*Lepidium latifolium*
Pigweed	*Amaranthus* spp.
Plantain	*Plantago* spp.
Pumpkin	*Cucurbita* spp.
Ragweed	*Ambrosia* spp.
Ragweed, Canyon	*Ambrosia ambrosioides*
Rhubarb, Alaska Wild	*Polygonum alpinum*
Rose	*Rosa* spp.
Salvia	*Salvia* spp.
Salvinia, Giant (Kariba-weed)	*Salvinia molesta*
Skeletonweed, Rush	*Chondrilla juncea*
Snakeweed	*Gutierrezia* spp.
Snakeweed, Broom	*Gutierrezia sarothrae*
Sowthistle	*Sonchus* spp.
Spurge, Leafy	*Euphorbia esula*
Squash	*Cucurbita* spp.
St. Johnswort, Common	*Hypericum perforatum*
Star-thistle, Maltese	*Centaurea melitensis*
Star-thistle, Yellow	*Centaurea solstitialis*
Sweetclover, Yellow	*Melilotus alba*
Swordfern	*Polystichum munitum*
Tansy, Common	*Tanacetum vulgare*
Tansy, Mustard	*Descurainia* spp.
Tansy, Ragwort	*Senecio jacobaea*
Teasel	*Dipsacus* spp.
Thistle, Bull	*Cirsium vulgare*
Thistle, Canada	*Cirsium arvense*
Thistle, Chorro Creek Bog	*Cirsium fontinale* var. *obispoense*
Thistle, Musk	*Carduus nutans*
Thistle, Russian	*Salsola kali*
Thistle, Scotch	*Onopordum acanthium*
Toadflax	*Linaria* spp.
Toadflax, Dalmation	*Linaria dalmatica*
Toadflax, Yellow	*Linaria vulgaris*
Tobacco	*Nicotiana* spp.
Tule	*Scirpus* spp.
Wapato	*Sagittaria cuneata*
Waterlily	*Nymphaea* spp.

Common Name	Scientific Name
PLANTS (Cont.)	
Watermilfoil, Eurasian	*Myriophyllum spicatum*
Water-thyme	*Hydrilla verticillata*
Whitetop	*Cardaria draba*
Wormwood, Common	*Artemisia vulgaris*
Yellowhead, Desert	*Yermo xanthocephalus*
Shrubs and Trees	
Acacia	*Acacia* spp.
Acacia, Catclaw	*Acacia gregii*
Acacia, Whitethorn	*Acacia constricta*
Agave	*Agave* spp.
Alder	*Alnus* spp.
Alder, Green	*Alnus viridis*
Alder, Red	*Alnus rubra*
All Scale	*Atriplex polycarpa*
Ash	*Fraxinus* spp.
Ash, American Mountain	*Sorbus americana*
Ash, White	*Fraxinus americana*
Aspen	*Populus* spp.
Aspen, Quaking	*Populus tremuloides*
Azalea, Western	*Rhododendron occidentale*
Bayonet, Spanish	*Yucca harrimaniae*
Birch	*Betula* spp.
Birch, Dwarf (Arctic)	*Betula nana*
Birch, Paper	*Betula papyrifera*
Bitterbrush	*Purshia* spp.
Bitterbrush, Antelope	*Purshia tridentata*
Blackberry	*Rubus* spp.
Blueberry	*Vaccinium* spp.
Blueberry, Dwarf	*Vaccinium caespitosum*
Boxelder	*Acer negundo*
Broom, Scotch	*Cytisus scoparius*
Buckthorn, Cascara	*Frangula purshiana*
Buckthorn, Common	*Rhamnus cathartica*
Buckthorn, Hollyleaf	*Rhamnus crocea*
Burroweed	*Isocoma tenuisecta*
Bursage (Burr Ragweed)	*Ambrosia* spp.
Cactus, Pricklypear	*Opuntia* spp.
Cactus, Saguaro	*Carnegiea gigantea*
Ceanothus	*Ceanothus* spp.
Ceanothus, Desert	*Ceanothus greggii*
Ceanothus, Snowbrush	*Ceanothus velutinus*
Ceanothus, Wedgeleaf	*Ceanothus cuneatus*
Cedar, Alaska	*Cupressus nootkatensis*
Cedar, Eastern Red	*Juniperus virginana*
Cedar, Incense	*Calocedrus decurrens*
Cedar, Western Red	*Thuja plicata*
Chamise	*Adenostoma fasciculatum*
Chokecherry	*Prunus virginiana*
Cholla	*Cylindropuntia imbricata*
Christmasberry	*Crossopetalum ilicifolium*

Common Name	Scientific Name
PLANTS (Cont.)	
Cliffrose	*Purshia* spp.
Cloudberry	*Rubus chamaemorus*
Cottonwood	*Populus* spp.
Cottonwood, Black	*Populus balsamifera* ssp. *trichocarpa*
Cranberry, Bog	*Vaccinium oxycoccos*
Creosote Bush	*Larrea tridentata*
Crowberry	*Empetrum* spp.
Crown of Thorns	*Koeberlinia* spp.
Cypress, Monterey	*Cupressus macrocarpa*
Devil's Club	*Oplopanax horridus*
Douglas-fir	*Pseudotsuga menziesii*
Douglas-fir, Rocky Mountain	*Pseudotsuga menziesii* var. *glauca*
Elderberry	*Sambucus* spp.
Elm	*Ulmus* spp.
Fir	*Abies* spp.
Fir, Balsam	*Abies balsamea*
Fir, California Red	*Abies magnifica*
Fir, Corkbark	*Abies lasiocarpa* var. *arizonica*
Fir, Grand	*Abies grandis*
Fir, Noble	*Abies procera*
Fir, Pacific Silver	*Abies amabilis*
Fir, Silver	*Abies alba*
Fir, Subalpine	*Abies lasiocarpa*
Fir, White	*Abies concolor*
Gorse	*Ulex europaeus*
Greasewood	*Sarcobatus vermiculatus*
Hackberry	*Celtis* spp.
Hemlock	*Tsuga* spp.
Hemlock, Mountain	*Tsuga mertensiana*
Hemlock, Poison	*Conium maculatum*
Hemlock, Western	*Tsuga heterophylla*
Hickory	*Carya* spp.
Hopsage	*Grayia* spp.
Hopsage, Spiny	*Grayia spinosa*
Horsebrush	*Tetradymia* spp.
Huckleberry	*Vaccinium* spp.
Huckleberry, California	*Vaccinium ovatum*
Indianhemp	*Apocynum cannabinum*
Ironwood, Desert	*Olneya tesota*
Jojoba	*Simmondsia chinensis*
Joshua Tree	*Yucca brevifolia*
Juniper	*Juniperus* spp.
Juniper, Alligator	*Juniperus deppeana*
Juniper, Oneseed	*Juniperus monosperma*
Juniper, Rocky Mountain	*Juniperus scopulorum*
Juniper, Utah	*Juniperus osteosperma*
Juniper, Western	*Juniperus occidentalis*
Kinnikinnick	*Arctostaphylos uva-ursi*
Labrador Tea	*Ledum* spp.
Larch	*Larix* spp.

Common Name	Scientific Name
PLANTS (Cont.)	
Larch, Western	*Larix occidentalis*
Laurel, California	*Umbellularia californica*
Live Oak, Canyon	*Quercus chrysolepis*
Live Oak, Coast	*Quercus agrifolia* var. *oxyadenia*
Live Oak, Evergreen	*Quercus virginiana*
Live Oak, Interior	*Quercus wislizeni*
Live Oak, Shrub	*Quercus turbinella*
Locust	*Robinia* spp.
Madrone	*Arbutus* spp.
Madrone, Pacific	*Arbutus menziesii*
Mallow, Round-leaved	*Malva pusilla*
Manzanita	*Arctostaphylos* spp.
Manzanita, Pointleaf	*Arctostaphylos pungens*
Manzanita, Pringle	*Arctostaphylos pringlei*
Maple, Bigleaf	*Acer macrophyllum*
Maple, Red	*Acer rubrum*
Maple, Rocky Mountain	*Acer glabrum*
Maple, Vine	*Acer circinatum*
Mescal Bean	*Sophora secundiflora*
Mesquite	*Prosopis* spp.
Mesquite, Honey	*Prosopis glandulosa*
Mimosa	*Mimosa* spp.
Mormon Tea	*Ephedra viridis*
Mountain Mahogany	*Cercocarpus* spp.
Mountain Mahogany, Birchleaf	*Cercocarpus montanus* var. *glaber*
Oak	*Quercus* spp.
Oak, Blue	*Quercus douglasii*
Oak, Bur	*Quercus macrocarpa*
Oak, California Black	*Quercus kelloggii*
Oak, California Scrub	*Quercus berberidifolia*
Oak, Cherrybark	*Quercus pagoda*
Oak, Emory	*Quercus emoryi*
Oak, Englemann	*Quercus engelmannii*
Oak, Gambel	*Quercus gambelii*
Oak, Gray	*Quercus grisea*
Oak, Leather	*Quercus durata*
Oak, Oregon White	*Quercus garryana*
Oak, Poison	*Toxicodendron* spp.
Oak, Post	*Quercus stellata*
Oak, Sand Shinnery	*Quercus havardii*
Oak, Shinnery	*Quercus harardii*
Oak, Scrub	*Quercus dumosa*
Oak, Valley	*Quercus lobata*
Oak, White	*Quercus alba*
Ocotillo	*Fouquieria splendens*
Olive, Russian	*Elaeagnus angustifolia*
Oregon Grape	*Mahonia* spp.
Oxytrope, Blackish	*Oxytropis nigrescens*
Paloverde	*Parkinsonia* spp.
Paloverde, Blue	*Parkinsonia florida*

Common Name	Scientific Name
PLANTS (Cont.)	
Pine, Bishop	*Pinus muricata*
Pine, Bristlecone	*Pinus aristata*
Pine, Coulter	*Pinus coulteri*
Pine, Digger	*Pinus sabiniana*
Pine, Jack	*Pinus banksiana*
Pine, Jeffrey	*Pinus jeffreyi*
Pine, Limber	*Pinus flexilis*
Pine, Lodgepole	*Pinus contorta* var. *latifolia*
Pine, Longleaf	*Pinus palustris*
Pine, Monterey	*Pinus radiata*
Pine, Pitch	*Pinus rigida*
Pine, Ponderosa	*Pinus ponderosa*
Pine, Red	*Pinus resinosa*
Pine, Shore	*Pinus contorta* var. *contorta*
Pine, Shortleaf	*Pinus echinata*
Pine, Sugar	*Pinus lambertiana*
Pine, Torrey	*Pinus torreyana*
Pine, Western White	*Pinus monticola*
Pine, Whitebark	*Pinus albicaulis*
Pinyon	*Pinus edulis*
Pinyon, Mexican	*Pinus cembroides*
Pinyon, Singleleaf	*Pinus monophylla*
Pinyon, Twoneedle	*Pinus edulis*
Poplar	*Populus* spp.
Poplar, Balsam	*Populus balsamifera*
Rabbitbrush	*Chrysothamnus* spp., *Ericameria* spp.
Rabbitbrush, Rubber	*Ericameria nauseosa*
Redwood	*Sequoia sempervirens*
Rhododendron, Pacific	*Rhododendron macrophyllum*
Rose, Wild	*Rosa* spp.
Rosemary, Bog	*Andromeda polifolia*
Sagebrush	*Artemisia* spp.
Sagebrush, Basin Big	*Artemisia tridentata* ssp. *tridentata*
Sagebrush, Big	*Artemisia tridentata*
Sagebrush, Black	*Artemisia nova*
Sagebrush, Coastal	*Artemisia californica*
Sagebrush, Little	*Artemisia arbuscula*
Sagebrush, Mountain Big	*Artemesia tridentata* ssp. *vaseyana*
Sagebrush, Silver	*Artemisia cana*
Sagebrush, Threetip	*Artemisia tripartita*
Sagebrush, Wyoming Big	*Artemisia tridentata* ssp. *wyomingensis*
Salal	*Gaultheria shallon*
Salmonberry	*Rubus spectabilis*
Saltbush	*Atriplex* spp.
Saltbush, Fourwing	*Atriplex canescens*
Saltbush, Shadscale	*Atriplex confertifolia*
Saltcedar (Tamarisk)	*Tamarix ramosissima*
Sassafras	*Sassafras albidum*
Sequoia, Giant	*Sequoiadendron giganteum*
Serviceberry	*Amelanchier* spp.

Common Name	Scientific Name
PLANTS (Cont.)	
Silktassel, Ashy	*Garrya flavescens*
Smoketree, European	*Cotinus coggygria*
Snowberry, Common	*Symphoricarpos albus*
Soapberry	*Sapindus* spp.
Sorrel, Redwood	*Oxalis oregana*
Sourberry	*Rhus integrifolia*
Spruce	*Picea* spp.
Spruce, Black	*Picea mariana*
Spruce, Blue	*Picea pungens*
Spruce, Engelmann	*Picea engelmannii*
Spruce, Sitka	*Picea sitchensis*
Spruce, White	*Picea glauca*
Sumac	*Rhus* spp.
Tallow, Chinese	*Triadica sebifera*
Tamarack	*Larix laricina*
Tanoak	*Lithocarpus densiflorus*
Tarbush	*Flourensia cernua*
Tea, Mormon	*Ephedra viridis*
Thornbush	*Lycium fremontii*
Twinflower	*Linnaea borealis*
Walnut	*Juglans* spp.
Willow	*Salix* spp.
Willow, Desert	*Chilopsis linearis*
Willow, Scouler's	*Salix scouleriana*
Yew, Western (Pacific)	*Taxus brevifolia*
Yucca	*Yucca* spp.
INVERTEBRATES	
Beetle, Asian Leaf	*Diorhabda elongata deserticola*
Beetle, Black-margined Loosestrife	*Galerucella calmariensis*
Beetle, Flea	*Aphthona* spp.
Beetle, Golden Loosestrife	*Galerucella pusilla*
Bug, Pirate	*Lyctocoris campestris*
Butterfly	Lepidoptera
Butterfly, Oregon Silverspot	*Speyeria zerene hippolyta*
Caddisfly	Trichoptera
Earthworm	*Oligochaeta* spp.
Flea, Water	*Daphnia magna*
Lacewing, Green	*Chrysoperla rufilabris*
Mayfly	Ephemeroptera
Midge	Tendipedidae
Mosquito	*Ochlerotatus* spp.
Scud, Water	*Hyallela* spp.
Shrimp, Glass	*Palaemonetes kadiakensis*
Slug, Banana	*Ariolimax columbianus*
Stonefly	Plecoptera
Weevil, Blunt Loosestrife Seed	*Nanophyes brevis*
Weevil, Loosestrife Root	*Hylobius transversovittatus*
Weevil, Salvinia	*Cyrtobagous salviniae*
Weevil, Seed-head	*Larinus latus*
Bass	*Micropterus* spp.

Common Name	Scientific Name
FISH	
Bass, Largemouth	*Micropterus salmoides*
Bass, Smallmouth	*Micropterus dolomieu*
Candlefish	*Thaleichthys pacificus*
Carp	*Cyprinus* spp.
Carp, Common	*Cyprinus carpio*
Carp, Grass	*Ctenopharyngodon idella*
Catfish, Channel	*Ictalurus punctatus*
Chub, Bonytail	*Gila elegans*
Chub, Humpback	*Gila cypha*
Chub, Sicklefin	*Macrhybopsis meeki*
Chub, Sturgeon	*Macrhybopsis gelida*
Cod	*Boregogadus* spp.
Crappie, White	*Pomoxis annularis*
Dace, Foskett Speckled	*Rhinichthys osculus*
Dace, Longfin	*Agosia chrysogaster*
Halibut	*Hippoglossus* spp.
Minnow, Fathead	*Pimephales promelas*
Minnow, Silvery	*Hybognathus* spp.
Paddlefish	*Polyodon spathula*
Pike, Northern	*Esox lucius*
Pikeminnow, Colorado	*Ptychocheilus lucius*
Pupfish	*Cyprinodon* spp.
Pupfish, Devil's Hole	*Cyprinodon diabolis*
Salmon, Chinook	*Oncorhynchus tshawytscha*
Salmon, Chum	*Oncorhynchus keta*
Salmon, Coho	*Oncorhynchus kitsch*
Salmon, Pink	*Oncorhynchus gorbusca*
Shiner, Red	*Cyprinella lutrensis*
Stickleback, Unarmored Threespine	*Gasterosteus aculeatus wiliamsoni*
Sturgeon	*Acipenser* spp.
Sturgeon, Pallid	*Scaphirhynchus albus*
Sucker, Desert	*Castromus clarki*
Sucker, Razorback	*Xyrauchen texanus*
Sunfish	*Lepomis* spp.
Sunfish, Bluegill	*Lepomis macrochirus*
Sunfish, Green	*Lepomis cyanellus*
Trout, Apache	*Oncorhynchus apache*
Trout, Brook	*Salvelinus fontinalis*
Trout, Brown	*Salmo trutta*
Trout, Bull	*Salvelinus confluentus*
Trout, Cutthroat	*Oncorhynchus clarki clarki*
Trout, Bonneville Cutthroat	*Oncorhynchus clarki utah*
Trout, Lahontan Cutthroat	*Oncorhynchus clarki henshawi*
Trout, Gila	*Oncorhynchus gilae*
Trout, Lake	*Salvelinus namaycush*
Trout, Rainbow (Steelhead)	*Oncorhynchus mykiss*
Trout, Redband	*Oncorhynchus mykiss* ssp.
Walleye	*Stizostedion vitreum*

Common Name	Scientific Name
AMPHIBIANS and REPTILES	
Chuckwalla	*Sauromalus ater*
Ensatina	*Ensatina eschscholtzii*
Frog, Wood	*Rana sylvatica*
Frog, Columbia Spotted	*Rana luteiventris*
Iguana, Desert	*Dipsosaurus dorsalis*
Lizard, Alligator	*Elgaria multicarinata multicarinata*
Lizard, Blunt-Nosed Leopard	*Gambelia silus*
Lizard, Sagebrush	*Sceloporus graciosus*
Lizard, Yucca Night	*Xantusia vigilis vigilis*
Rattlesnake, Western	*Crotalus viridis*
Salamander, Clouded	*Aneides ferreus*
Salamander, Mount Lyell	*Hydromantes platycephalus*
Salamander, Olympic	*Rhyacotriton olympicus*
Salamander, Oregon Slender	*Batrachoseps wrighti*
Salamander, Pacific Giant	*Dicamptodon tenebrosus*
Salamander, Relictual Slender	*Batrachoseps relictus*
Salamander, Western Red-backed	*Plethodon vehiculum*
Snake, Common Garter	*Taricha sirtalis*
Snake, Northwestern Garter	*Thamnophis ordinoides*
Toad, Spadefoot	*Scaphiopus* spp.
Tortoise, Desert	*Gopherus agassizii*
Turtle, Painted	*Chrysemys picta*
Turtle, Western Pond	*Clemmys marmorata*
BIRDS	
Bobolink	*Dolichonyx oryzivorus*
Bobwhite, Masked	*Colinus virginianus ridgewayi*
Bushtit	*Psaltriparus minimus*
Chickadee	*Poecile* spp.
Chukar	*Alectoris chukar*
Creeper	*Certhia* spp.
Crossbill, White-winged	*Loxia leucoptera*
Crow, American	*Corvus brachyrhynchos*
Dove, Mourning	*Zenaida macroura*
Eagle, Bald	*Haliaeetus leucocephalus*
Eagle, Golden	*Aquila chrysaetos*
Eider, Spectacled	*Somateria fischeri*
Eider, Stellar's	*Polysticta stelleri*
Falcon, Peregrine	*Falco peregrinus*
Flicker, Gilded	*Colaptes chrysoides*
Flycatcher, Brown-crested	*Myiarchus tyrannulus*
Flycatcher, Southwestern Willow	*Empidomax trallii extimus*
Flycatcher, Vermilion	*Pyrocephalus rubinus*
Flycatcher, Willow	*Empidonax traillii*
Gnatcatcher, Black-tailed	*Polioptila melanura*
Gnatcatcher, California	*Polioptila californica*
Goshawk, Northern	*Accipiter gentilis*
Grouse, Columbian Sharp-tailed	*Tympanuchus phasianellus columbianus*
Grouse, Greater Sage-	*Certracercus urophasianus*
Grouse, Ruffed	*Bonasa umbellus*
Grousc, Sharp-tailed	*Tympanuchus phasianellus*

Common Name	Scientific Name
BIRDS (Cont.)	
Grouse, Spruce	*Falcipennis canadensis*
Gyrfalcon	*Falco rusticolus*
Hawk, Ferruginous	*Buteo regalis*
Hawk, Rough-legged	*Buteo lagopus*
Hen, Heath	*Tympanuchus cupido cupido*
Hummingbird	Trochilidae
Jay, Pinyon	*Gymnorhinus cyanocephalus*
Jay, Scrub	*Aphelocoma californica*
Jay, Steller's	*Cyanocitta stelleri*
Junco, Dark-eyed	*Junco hyemalis*
Kinglet	*Regulus* spp.
Lark, Horned	*Eremophila alpestris*
Meadowlark, Western	*Sturnella neglecta*
Mockingbird, Northern	*Mimus pollyglatos*
Murrelet, Marbled	*Brachyramphus marmoratus*
Nutcracker, Clark's	*Nucifraga columbiana*
Nuthatch	*Sitta* spp.
Ovenbird	*Seiurus aurocapilla*
Owl, Burrowing	*Athene cunicularia*
Owl, Elf	*Micrathene whitneyi*
Owl, Flammulated	*Otus flammeolus*
Owl, Snowy	*Bubu scandiacus*
Owl, California Spotted	*Strix occidentalis occidentalis*
Owl, Spotted	*Strix occidentalis*
Plover, Mountain	*Charadrius montanus*
Plover, Piping	*Charadrius melodus*
Plover, Western Snowy	*Charadrius alexandrinus*
Prairie Chicken, Greater	*Tympanuchus cupido*
Prairie Chicken, Lesser	*Tympanuchus pallidicinctus*
Ptarmigan, Willow	*Lagopus lagopus*
Quail, California	*Callipepla californica*
Quail, Gambel's	*Callipepla gambelii*
Quail, Mountain	*Oreortyx pictus*
Quail, Northern Bobwhite	*Colinus virginianus*
Quail, Scaled	*Callipepla squamata*
Rail, Yuma Clapper	*Rallus longirostris yumanensis*
Raven, Common	*Corvus corax*
Robin, American	*Turdus americanus*
Sparrow, Black-throated	*Amphispiza bilineata*
Sparrow, Brewer's	*Spizella breweri*
Sparrow, Cassin's	*Aimophila cassinii*
Sparrow, Grasshopper	*Ammodramus savannarum*
Sparrow, Lark	*Chondestes grammacus*
Sparrow, Sage	*Amphispiza belli*
Sparrow, Savannah	*Passerculus sandwichensis*
Sparrow, Vesper	*Pooecetes gramineus*
Swift, Vaux's	*Chaetura vauxi*
Thrasher, California	*Toxostoma redivivum*
Thrasher, Sage	*Oreoscoptes montanus*
Thrush, Hermit	*Catharus guttatus*

Common Name	Scientific Name
BIRDS (Cont.)	
Thrush, Swainson's	*Catharus ustulatus*
Titmouse, Plain	*Baeolophus inornatus; B. ridgewayi*
Towhee, Spotted	*Pipilo maculatus*
Turkey, Wild	*Meleagris gallopavo*
Vireo	*Vireo* spp.
Woodpecker	*Melanerpes* spp.
Woodpecker, Acorn	*Melanerpes formicivorus*
Woodpecker, Black-backed	*Picoides arcticus*
Woodpecker, Gila	*Melanerpes uropygialis*
Woodpecker, Golden-fronted	*Melanerpes aurifrons*
Woodpecker, Lewis'	*Melanerpes lewis*
Wren, Cactus	*Campylorhynchus brunneicapillus*
Wren, Winter	*Troglodytes troglodytes*
Wrentit	*Chamaea fasciata*
MAMMALS	
Antelope, Pronghorn	*Antilocapra americana*
Antelope, Sonoran Pronghorn	*Antilocapra americana sonoriensis*
Badger, American	*Taxidea taxus*
Bat, Lesser Long-nosed	*Leptonycteris curosoae yerbabuenae*
Bat, Mexican Long-nosed	*Leptonycteris nivalis*
Bat, Pocketed Free-tail	*Nyctinomops femorosaccus*
Bear	*Ursus* spp.
Bear, Black	*Ursus americanus*
Bear, Grizzly (Brown)	*Ursus arctos*
Bear, Polar	*Ursus maritimus*
Beaver, American	*Castor canadensis*
Bison, American	*Bison bison*
Bobcat	*Felis rufus*
Buffalo, American	*Bison bison*
Burro	*Equus asinus*
Caribou	*Rangifer tarandus*
Chipmunk	*Eutamias* spp.
Coatimundi	*Nasua narica*
Cottontail	*Sylvilagus* spp.
Cottontail, Desert	*Sylvilagus audubonі*
Cougar	*Puma concolor*
Coyote	*Canis latrans*
Deer	*Odocoileus* spp.
Deer, Black-tailed	*Odocoileus hemionus*
Deer, Mule	*Odocoileus hemionus*
Deer, White-tailed	*Odocoileus virginianus*
Elk	*Cervus elaphus*
Ferret, Black-footed	*Mustela nigripes*
Fox, Arctic	*Alopex lagopus*
Fox, Gray	*Urocyon cinereoargenteus*
Fox, Kit	*Vulpes macrotis*
Fox, Red	*Vulpes vulpes*
Fox, Swift	*Vulpes velox*
Goat, Mountain	*Oreamnos americanus*
Gopher, Northern Pocket	*Thomomys talpoides*

Common Name	Scientific Name
MAMMALS (Cont.)	
Gopher, Pocket	*Thomomys* spp.
Hare, Snowshoe	*Lepus americanus*
Horse	*Equus caballus*
Jackrabbit	*Lepus* spp.
Jackrabbit, Black-tailed	*Lepus californicus*
Jaguar	*Panthera onca*
Lemming, Brown	*Lemmus trimucronatus*
Marmot, Hoary	*Marmota caligata*
Mole	*Talpidae* spp.
Marten, American	*Martes americana*
Moose	*Alces alces*
Mountain Lion	*Puma concolor*
Mouse, California	*Peromyscus californicus*
Mouse, Deer	*Peromyscus maniculatus*
Mouse, Pinyon	*Peromyscus truei*
Mouse, Preble's Meadow Jumping	*Zapus hudsonius preblei*
Muskox	*Ovibos moschatus*
Ocelot	*Felis pardalis*
Peccary, Collared	*Tayassu tajacu*
Prairie Dog	*Cynomys* spp.
Prairie Dog, Black-tailed	*Cynomys ludovicianus*
Prairie Dog, Utah	*Cynomys parvidens*
Prairie Dog, White-tailed	*Cynomys leucurus*
Rabbit, Brush	*Sylvilagus bachmani*
Rat, Desert Kangaroo	*Dipodomys deserti*
Rat, Giant Kangaroo	*Dipodomys ingens*
Rat, Merriam's Kangaroo	*Dipodomys merriama*
Reindeer	*Rangifer tarandus*
Sheep, Bighorn	*Ovis canadensis*
Sheep, Dall	*Ovis dalli*
Sheep, Desert Bighorn	*Ovis canadensis nelsoni*
Shrew	Soricidae
Skunk	*Mephitis* spp.
Skunk, Hooded	*Mephitis macroura*
Skunk, Striped	*Mephitis mephitis*
Squirrel, Abert's	*Sciurus aberti*
Squirrel, Arctic Ground	*Spermophilus parryii*
Squirrel, California Ground	*Citellus beecheyi*
Squirrel, Northern Flying	*Glaucomys sabrinus*
Squirrel, Idaho Ground	*Spermophilus brunneus*
Squirrel, Mexican Ground	*Spermophilus mexicanus*
Squirrel, Northern Idaho Ground	*Spermophilus brunneus brunneus*
Squirrel, Washington Ground	*Spermophilus washingtoni*
Squirrel, Western Gray	*Sciurus griseus*
Vole, Montane	*Microtus montanus*
Weasel	*Mustela* spp.
Wolf, Gray	*Canis lupus*
Wolverine	*Gulo gulo*
Woodchuck	*Marmota monax*
Woodrat	*Neotoma* spp.

Common Name	Scientific Name
MAMMALS (Cont.)	
Woodrat, Dusky-footed	*Neotoma fuscipes*
Woodrat, Riparian	*Neotoma fuscipes riparia*

APPENDIX B

MANUALS AND HANDBOOKS

APPENDIX B

REFERENCE MANUALS AND HANDBOOKS

General and specific program direction, such as policy, required procedures, and standards concerning the use of renewable resource improvements are contained in a number of BLM Manual Sections and Handbooks. The following list of references provides a general index to this information for use by BLM managerial and staff personnel. A complete listing of all BLM Section Codes can be found in Appendix 3, pages 93-168 in BLM Manual Section 1220 Records and Information Management and is available at: http://www.blm.gov/nhp/efoia/wo/manual/1220.pdf.

Manual Section 620	Wildland Fire Management
Manual Section 1112	Safety
Manual Section 1220	Records and Information Management
Manual Section 1510	Procurement
Manual Section 1601	Bureau Planning System
Handbook H-1601-1	Land Use Planning Handbook
Manual Section1616	Prescribed Resource Management Planning Actions
Manual Section 1617	Resource Management Plan Approval, Use, and Modification
Manual Section 1619	Activity Plan Coordination
Manual Sections 1620-1625	Supplemental Program Guidance
Manual Section 1734	Monitoring and Inventory Coordination
Manual Section 1740	Renewable Resource Improvements and Treatments
Handbook H-1740-1	Renewable Resource Improvement and Treatment Guidelines and Procedures
Manual Section 1741	Renewable Resource Improvements, Practices, and Standards
Handbook H-1741-1	Fencing
Handbook H-1741-2	Water Developments
Manual Section 1742	Emergency Fire Rehabilitation
Handbook H-1742-1	Emergency Fire Rehabilitation
Manual Section 1743	Renewable Resource Investment Analysis
Handbook H-1743-1	Resource Investment Analysis: User Handbook for the SageRam Computer Program
Manual Section 1745	Introduction, Transplant, Augmentation and Reestablishment of Fish, Wildlife and Plants.
Handbook H-1790-1	National Environmental Policy Act Handbook
Manual Section 2920	Leases, Permits, and Easements
Manual Section 4010	Range Management Program Records
Handbook H-4010-1	Range Management Program Records
Manual Section 4100	Grazing Administration – Exclusive of Alaska
Manual Section 4120	Grazing Management
Handbook H-4120-1	Grazing Management

Manual Section 4180	Rangeland Health Standards
Handbook H-4180-1	Rangeland Health Standards
Manual Section 4400	Rangeland Inventory, Monitoring, and Evaluation
Handbook H-4400-1	Rangeland, Inventory, Monitoring, and Evaluation
Handbook H-4410-1	National Range Handbook
Manual Section 5000	Forest Management
Manual Section 5000-1	Forest Management Public Domain
Manual Section 5400	Sales of Forest Products
Handbook H-6310-1	Wilderness Inventory and Study Procedures
Manual Section 6500	Wildlife and Fisheries Management
Manual Section 6780	Habitat Management Plans
Manual Section 6840	Special Status Species Management
Manual Section 7000	Soil, Water, and Air Management
Manual Section 8100	The Foundations for Managing Cultural Resources
Manual Section 8110	Identifying and Evaluating Cultural Resources
Manual Section 8120	Tribal Consultation under Cultural Resources Authorities
Handbook H-8120-1	General Procedural Guidance for Native American Consultation
Manual Section 8130	Planning for Uses of Cultural Resources
Manual Section 8140	Protecting Cultural Resources
Manual Section 8150	Permitting Uses of Cultural Resources
Handbook H-8160-1	General Procedural Guidelines for Native American Consultation
Manual Section 8170	Interpreting Cultural Resources for the Public
Manual Section 8270	Paleontological Resource Management
Handbook H-8270-1	General Procedural Guidance for Paleontological Resource Management
Manual Section 8351	Wild and Scenic Rivers – Policy and Program Direction for Identification, Evaluation, and Management
Manual Section 8400	Visual Resource Management
Handbook H-8410-1	Visual Resource Inventory
Manual Section 8431	Visual Resource Contrast Rating
Handbook H-8550-1	Interim Management Policy for Lands under Wilderness Review
Manual Section 8560	Management of Designated Wilderness Areas
Handbook H-8560-1	Wilderness Management
Manual Section 9011	Chemical Pest Control
Handbook H-9011-1	Chemical Pest Control
Manual Section 9012	Expenditure of Rangeland Insect Pest Control Funds
Manual Section 9014	Use of Biological Control Agents of Pest on Public Lands
Manual Section 9015	Integrated Weed Management
Manual Section 9100	Engineering
Manual Section 9101	Facility Planning
Manual Section 9102	Facility Design
Manual Section 9103	Facility Construction
Manual Section 9104	Facility Maintenance
Manual Section 9114	Trails

Manual Section 9132	Operational Signs
Manual Section 9172	Water Control Structures
Handbook H-9172-1	Water Control Structures – Guidelines for Design
Handbook H-9172-2	Water Control Structures –Guidelines for Construction Drawings
Manual Section 9177	Maintenance and Safety of Dams
Handbook H-9177-1	Performing Condition Surveys for Earth Embankment Dams
Handbook H-9177-2	Performing Emergency Action Plans
Handbook H-9177-3	Reporting Dam Failures
Manual Section 9182	Wastewater Treatment
Manual Section 9183	Municipal – Community Related Solid Waste
Manual Section 9184	Drinking Water Supply
Manual Section 9210	Fire Management
Manual Section 9211	Fire Planning
Handbook H-9211-1	Fire Management Activity Planning Procedures
Manual Section 9214	Prescribed Fire Management
Handbook H-9214-1	Prescribed Fire Management
Manual Section 9215	Fire Training and Qualifications
Manual Section 9218	Fire Reporting and Statistics
Manual Section 9220	Integrated Pest Management

APPENDIX C

TRIBAL AND AGENCY CONSULTATION

TRIBAL CONSULTATION

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Washington, D.C. 20240
http://www.blm.gov

July 3, 2002

RE: Bureau of Land Management (BLM) Vegetation Treatments Programmatic Environmental Impact Statement (EIS) for the Western U.S., Including Alaska

Dear Chairperson:

The Bureau of Land Management (BLM) is preparing a programmatic EIS to evaluate the impacts of the vegetative treatments on the environment and local economies. The BLM is proposing to treat vegetation on approximately six million acres annually in the western U.S., and Alaska. The purpose of these treatments is to conserve and restore the function of vegetation, watershed, and fish and wildlife habitat. Vegetation treatment methods could include mechanical, manual, chemical, biological, and cultural control, as well as prescribed fires. Cultural control utilizes goats and other animlas.

Approximately half the acres would be treated to restore historic fire regimes and to reduce the risk of wildfires on BLM-administered lands. The BLM estimated that 1-1-½ million acres of wildfire-damaged land would be treated annually under the Emergency Stabilization and Rehabilitation program. The BLM would manage the rest of the acreage under several programs, including the control of noxious weeds, invasive plants, and the restoration of damaged lands by seeding and replanting.

As part of the program, the BLM is proposing to evaluate five new herbicides for possible use on public lands in the EIS. We are currently assessing risk to humans, fish, and wildlife from use of these chemicals. In addition, BLM will develop a protocol as part of the EIS which will allow us to streamline the process of evaluation and approval of herbicides that may be developed in the future.

The vegetation treatment actions would occur on public lands administered by the BLM in Alaska, Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Texas, Washington, and Wyoming. The enclosed sheet titled "Frequently Asked Questions" discusses the vegetation treatment's program and the EIS, and the enclosed map shows the locations of BLM-administered lands in your State.

The programmatic EIS is designed to look at the broad impacts associated with the design to implement the vegetation treatment program. Because the program covers such a large area, assessing site-specific impacts in this EIS is not realistic. This approach will allow the future development of more site-specific National Environmental Policy Act documents, such as land-use plans and project-specific analysis. The need for repetitive discussion of the same issues in the site-specific documents will be eliminated.

The BLM is coordinating closely with other Federal, State, and local agencies, Native American Tribes, Alaska Native groups, and other stakeholders. The BLM recently completed public scoping and is in the process of reviewing comments and identifying alternative treatment actions to the proposed action. We anticipate that the Draft EIS will be completed later this fall.

The BLM seeks to address the effects of treatment methods on resources used by Native Americans and Alaska Native groups. We ask that you review the enclosed materials and inform us of any concerns you might have about any of the proposed vegetation treatments. We are particularly interested in potential impacts on subsistence plants and animals, and on traditional cultural properties. We are also interested in potential impacts on resources associated with reserved rights under treaty, where they exist. Could you tell us which of the treatment activities are of further concern to you? Please let us know whether you would like to provide information and if you would like to participate in the environmental process by receiving review copies of the documents that we produce. Continued consultation with the affected Indian Tribes and Alaska Native groups will occur during the development and implementation of special projects by BLM field offices. We will keep you informed as to the progress of the project. You may also visit the BLM website to learn more about the project: http://www.blm.gov/weeds/VegEIS/index.htm.

Thank you for your time and consideration of this request. We would appreciate your response within 30 days. If you have any questions, concerns, or would like additional information, please contact Gina Ramos, co-team lead at 202-452-4084 or Brian Amme, Project Manager at 775-861-6645.

Sincerely,

Edward Doty

Assistant Director, Renewable Resources
and Planning

2 Enclosures
1 - Frequently Asked Questions
2 - Project Area Map

BUREAU OF LAND MANAGEMENT

VEGETATION TREATMENTS PROGRAMMATIC EIS FOR THE WESTERN U.S. AND ALASKA

Frequently Asked Questions

Project Description

Q. What is the Bureau of Land Management (BLM) proposing to do?
A. The BLM is proposing to treat soil and vegetation on an estimated 6 million acres annually in the western U.S. and Alaska. The purpose of these treatments would be to conserve and restore vegetation, fish and wildlife habitat, and watershed functions using several treatment methods. Mechanical, manual, chemical, biological, and cultural (use of goats and other animals) treatment methods, and prescribed fire, would be used to treat vegetation.

Over half of the acres would be treated to restore historic fire regimes and reduce the risk of wildfire on BLM-administered lands. An estimated one million acres damaged by wildfires would be treated annually under the Emergency Stabilization and Rehabilitation Program. The remaining acreage would be managed under several BLM programs, and management would primarily involve the control of noxious weeds and invasive plants, and the restoration of damaged lands by seeding and replanting.

In addition, the BLM may be allowed to use several proposed herbicides that will be evaluated in the EIS, as well as new chemicals that may be developed in the future.

Q. Where would the proposed actions occur?
A. The vegetation treatment actions would occur on public lands administered by the BLM in the western U.S. and Alaska. The majority of these lands are in Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Q. Will the EIS include National Monuments and National Conservation Areas?
A. Yes, since they are included in the project area. These units will be analyzed as part of the broad programmatic treatment area to the extent that conservation and restoration project work, including invasive and noxious weed treatments, are allowed by the individual National Landscape Conservation System proclamations.

Q. How is this project different from what the BLM is already doing?
A. The BLM is currently authorized under earlier National Environmental Policy Act (NEPA) programmatic EISs to treat vegetation on approximately 500,000 acres in the western U.S.; however, Alaska was not included in the analyses in these EISs. Under the proposed program, the BLM would be able to treat several million more acres annually, and treatment activities in Alaska would also be covered under this EIS.

Q. Why does the BLM need to treat several million more acres annually?
A. Numerous large wildfires in the west in recent years have made it imperative that wildfire fuels be reduced to decrease the potential for future catastrophic wildfires. Over half of the acres would be treated to restore historic fire regimes and to reduce risk of wildfire on BLM-administered lands, especially those near urban areas. Over a million acres of lands burned by wildfires would be restored annually by seeding and planting. The remaining acres would be treated under several BLM programs, and management would primarily involve the control of noxious weeds and invasive plants.

EIS Development Process

Q. Why is the BLM developing this EIS?
A. The BLM is preparing a programmatic EIS to evaluate the impacts of treatments for the conservation and restoration of vegetation, watershed, and fish and wildlife habitat on surface lands administered by the BLM in the western U.S., including Alaska. The BLM is developing the EIS to update and replace analyses contained in four existing vegetation treatment EISs that were completed between 1986 and 1992. These documents are becoming less useful because new information is now available, and conditions and circumstances influencing treatment requirements have changed. For example, several new fire initiatives, including the National Fire Plan, Integrated Weed Management Plan, and Great Basin Restoration Initiative, have identified a need to do more vegetative treatments across the landscape to reduce the risks of wildfires and to control noxious weeds. The EIS is also being developed to analyze similar activities on BLM-administered lands in Alaska, which were not included in the earlier EISs.

Q. What is the purpose of the EIS?
A. The EIS will: (1) provide a comprehensive analysis of BLM conservation and restoration activities involving the treatment, modification, or restoration of vegetation, fish and wildlife habitat, and watersheds; (2) provide a comprehensive programmatic NEPA document for use by local BLM field offices for local land-use planning; (3) serve as a baseline cumulative impact assessment; (4) assess human and environmental health risks from proposed new herbicides and prescribed burning activities; and (5) consider state-specific activities, including hazardous fuels treatments, to protect communities and restore desired natural fire regimes.

Q. Is the EIS a land-use plan?
A. No, the EIS is neither a land-use plan nor an amendment to a land-use plan. As a programmatic EIS, it will not determine land use on the public lands and will not address specific agency management decisions developed under local land use plans.

Q. What is the difference between a programmatic EIS and project-specific EIS?
A. A programmatic EIS is designed to look at the broad, generic impacts associated with a decision to fully implement a program. Because this EIS covers vegetation treatment activities on 15 states, it is not realistically possible to assess site-specific impacts associated with the program. A programmatic EIS also allows for the tiering of more site-specific NEPA documents, such as land-use plans, eliminating the need for repetitive discussions of the same issues. A project-specific EIS looks at impacts associated with a site-specific project, such as vegetation treatment activities on 1,000 acres of BLM-administered lands.

Q. How will this EIS affect current and future local land-use plans?
A. There should be little effect on current land-use plans. However, the programmatic EIS should minimize the need for cumulative impact documentation in future individual land-use plans, revisions, amendments, and EISs. The EIS will act as an umbrella document under which the local field offices can develop local land-use plans by providing comprehensive general guidelines, and will serve as a baseline cumulative impact assessment.

Q. Who is developing the EIS?
A. The BLM Office of Rangelands, Soils, Water and Air in Washington, D.C., is leading the project, supported by BLM technical resource specialists in BLM offices throughout the western U.S. and Alaska. ENSR International, a third-party contractor, will conduct the public meetings and prepare the EIS in accordance with BLM guidelines and oversight.

Q. Are there any other federal agencies involved in the effort?
A. There are no other federal agencies involved as cooperating agencies; however, the project is being closely coordinated with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Environmental Protection Agency.

Q. Are tribal, state, and local governments involved in the EIS process?
A. The BLM will coordinate closely with tribal, state, and local governments, the National Association of Counties, and the Western Governors Association throughout development of the EIS.

Q. How much has been done so far, and what is the next step?
A. The Notice of Intent to develop the EIS was published in the Federal Register on October 12, 2001, and a news release was distributed to the media, interested groups, and state agencies by the BLM at the same time. A notice of the extension of the public comment period and the schedule for scoping meetings was published in the Federal Register on January 2, 2002, and a "Questions and Answers" information sheet was distributed on the same date. Nineteen public scoping meetings will be held throughout the western U.S., and in Alaska and Washington, D.C., during January through mid March.

Q. When is the EIS scheduled for completion?
A. The Draft EIS is scheduled to be completed in the fall of 2002, and the Final EIS in late summer 2003.

Potential Issues to Be Examined in the EIS

Q. Does this EIS involve controversial issues?
A. It is anticipated that most public scrutiny will focus on issues associated with the use of prescribed fire and restoration of fire-adapted ecosystems, and the use of herbicides to control noxious weeds and other vegetation. Specific issues to be addressed in the EIS include the impacts of wildfires and prescribed fires on regional air quality; effects of herbicides on human and environmental health; effects of treatment methods on threatened and endangered species; and effects of treatment methods on resources used by Native Americans and Alaska Native groups.

Q. What issues will this EIS not cover?
A. The EIS will not address vegetation management that is primarily focused on commercial timber or other forest product enhancement and use, livestock forage enhancement and use, abandoned mine land reclamation, and energy production. The EIS will not analyze fire suppression operations and soil stabilization, except where related to vegetation treatment. The EIS also will not make land use allocations, or evaluate off-road vehicle use of BLM-administered lands.

Q. Will there be an assessment of risks to the public and the environment from the use of herbicides and prescribed burning?
A. A risk assessment will be done to determine the likely risks to humans and wildlife from the treatments involving new herbicides proposed for use by the BLM, and from prescribed burning. The EIS will not evaluate the risks from herbicides presently being used by the BLM, which have already been evaluated in the earlier EISs, unless new information has become available to suggest that these herbicides require further evaluation.

Q. Will the EIS include alternatives for treating vegetation and mitigation?
A. Yes, the EIS will include alternative proposals for treating vegetation, including the use of preventive measures and operational procedures to reduce impacts to humans and the environment.

Q. Will there be a process developed to determine which new chemicals the BLM can use to control vegetation?
A. Yes, the EIS will also include protocol that the BLM should follow to evaluate new chemicals that may be developed in the future, prior to their use by the agency. These herbicides could only be used if they are: (1) registered for use by the EPA; (2) used for treatment of appropriate vegetation types and at application rates specified on the label directions; and (3) determined to be safe to humans and the environment based on a toxicological and environmental impacts analysis of the herbicides by the BLM.

Public Involvement

Q. When will the public be able to make comments on the project?
A. NEPA regulations require federal agencies to seek public input during development of the EIS. The public will have several opportunities to discuss this project with the BLM and to make comments, such as:

- At public scoping meetings held in 19 cities from January 8 through March 12, 2002.
- By submitting comments on issues identified in the scoping process and any additional issues that should be addressed, through March 29, 2002.
- By submitting comments through additional public comment periods associated with the Draft EIS and Final EIS.

Q. How can the public comment on the program?
A. The public can provide formal comments to the court reporter who will be available during each scoping meeting. Forms to submit written comment will also be available during the scoping meeting, and at local BLM offices, and can be turned in to the BLM at the scoping meeting or local office. These forms, or other written comments, can also be mailed to: Brian Amme, Project Manager, Bureau of Land Management, P.O. Box 12000, Reno, NV 89520-0006. Comments can also be faxed to Mr. Amme at (775) 861-6712.

Q. What will be done with these comments?
A. The comments will be compiled and summarized by major resource areas and issues in a scoping summary report. Public comments, and the scoping summary report, will be used to evaluate issues and concerns associated with the proposed program, and to develop alternative programs to treat vegetation on BLM-administered lands. Alternative programs could involve vegetation treatment using fewer treatment methods than are currently proposed by the BLM, or different amounts of acres treated using each method. The scoping summary report will be made available to the public in late spring.

Q. How can I find out more about the project, review the earlier EISs, and follow the progress of the EIS?
A. A website is currently under construction on the BLM website (www.blm.gov) and will be available in February 2002.

National Science & Technology Center
Bureau of Land Management

California

BLM-Administered Lands

BLM National Monument

BLM National Conservation Area

State Office

Field Office

Field Office (Tier 3)

BLM State Jurisdiction

Field Office Jurisdiction

Field Office Jurisdiction (Tier 3)

County Line

State Line

In addition to the surface acreage shown, the BLM manages 47.5 million acres of subsurface mineral estate for this state jurisdiction.

For more information on this data, contact Keith Francis at NSTC, keith_francis@blm.gov or 303-236-0113.

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Mr. James W. Garrison, SHPO
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RECEIVED
BUR. OF LAND MANAGEMENT
NEVADA STATE OFFICE
02 AUG 15 AM 7:3

August 13, 2002

Brian Amme
Project Manager
Bureau of Land Management
P.O. BOX 12000
Reno, NV 89520-0006

Re: Bureau of Land Management (BLM) Vegetation Treatments Programmatic Environmental Impact Statement (EIS) for the Western U.S., Including Alaska

Dear Mr. Amme:

We have received the information report prepared for the above-referenced project that BLM is proposing. The purpose of these treatments is to conserve and restore the function of vegetation, watershed, and fish and wildlife habitat and including control of noxious weeds, and the restoration of damaged lands by seeding and replanting.

Thank you for providing the Omaha Tribe with the opportunity to review this undertaking.

We make comment based on the enclosed material, we would like to participate in the environmental process by receiving copies of the documents that BLM produces.

Please keep us informed as to the progress of the project or any additional information.

Feel free to contact this office (402) 837-5391 if you have any questions.

Sincerely,

Kenneth Lyons

Kenneth Lyons
Real Estate Services
Omaha Tribe of Nebraska

OMAHA TRIBE OF NEBRASKA
U'MON'HA TRIBE
1815 HERITAGE FOR PEACE

Scotts Valley Band of Pomo Indians

July 22, 2002

Brian Amme
Project Manager Vegetation/Habitat Treatments
Bureau of Land Management
P.O. Box 12000
Reno, NV. 89520-0006

Dear Mr. Amme,

I am writing this letter in response to the letter of July 3rd, 2002 requesting input from Tribal agencies about the Vegetation Treatment EIS. Pomo Tribes are world-renowned for the quality of their historic basketweaving. Scotts Valley Band of Pomo Indians is in the process of restoring this tradition among Tribal members, including children. Because Traditional materials such as willow, sedge, and redbud are held in the mouth while splitting, our weavers are **very** concerned about chemical residues that may remain on plants as a result of spraying for vegetation control. The California Indian Basketweaver's Association has completed a study about the persistence of chemicals in the landscape (notably Round-up) that indicates long-term presence (up to 300+ days) in the landscape. This problem is especially important when large tracts of land are subjected to aerial spraying for vegetation control.

Traditional Pomo weavers managed their gathering sites with controlled burns, and therefore, Scotts Valley supports the use of fire as a management tool. We understand that this is controversial due to recent events, but with **closer attention to conditions in the field,** we feel fire can be an excellent management tool. Again, due to chemical residues left by kerosene products, we suggest using propane to start controlled burns in areas where basketweavers are likely to collect materials. The California Indian Basketweaver's Association has made this suggestion to the Parks Service and they are currently using the less detrimental product.

We appreciate your request for comments on this project, and hope that you will take our concerns seriously.

Sincerely,

Diana L. Hershey

Diana Hershey
Planning/Development Manager

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TOHONO O'ODHAM NATION
CULTURAL AFFAIRS DEPARTMENT
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Telephone (520) 383-3622 • Fax (520) 383-337

02 AUG -6 AM 7:

August 1, 2002

Brian Amme, Project Manager
Bureau of Land Management
P.O. Box 1200
Reno, Nevada 89520-0006

Dear Mr. Amme:

Thank you for the opportunity to review and comment on the proposed Bureau of Land Management Vegetation Treatments Programmatic Environmental Impact Statement (EIS) for the Western United States, including Alaska.

The Cultural Affairs Office has several comments and questions:

1. Concerns over types of herbicides, please send information on the five new herbicides you are considering for use. Effects on other plants, animals and people.
2. Areas that will be treated with mechanical or manual method that disturb the ground will require completion of archaeological surveys.
3. Once specific areas are identified, State BLM Office need to consult with the tribes in each state.
4. Effects on cultural resource properties need to be evaluated.
5. Effects on plants used by Native Americans for medicines or for crafts.
6. Please send copies of all relevant technical reports.
7. Tribes should be invited to be signatories of any programmatic agreements.
8. Please send copy of Draft EIS
9. Please send list of times and places for scooping meetings Please schedule scooping meetings for the Tohono O'odham Nation.
10. Effects of project on endangered species.

Sincerely,

Peter L Steere

Peter L. Steere
Manager, Cultural Affairs

TUOLUMNE ME-WUK TRIBAL COUNCIL
Post Office Box 699
TUOLUMNE, CALIFORNIA 95379

Telephone (209) 928-3475
Fax (209) 928-1677

United States Department of the Interior
Bureau of Land Management
Washington, DC 20240

To Whom It May Concern:

Subject: EIS for the Western U.S.

In regard to the correspondence received concerning the Programmatic Environmental Impact Statement for the Vegetation Treatments on BLM's Land; the Tribe would like to be kept up on any issues and would like to see a copy of the draft and final EIS statement.

We, as Native Americans are very concerned about the chemical uses on cultural plants, especially basket materials. We hope that the evaluating of the five new herbicides for possible use on public lands will include the long-range effects on cultural plants as well as the effects on our sacred water sources.

We are also concerned due to the fact that a lot of Pre-historical sites do not flag in cultural plants, which we feel are a large part of the cultural significance of any site. These unprotected cultural plants, outside the flag lines are then exposed to the herbicides used on our forestlands.

Thank you for giving us the opportunity to comment upon this large undertaking. We are looking forward to receiving the draft Environmental Statement so that we may also comment on that. If you have any questions you may contact Vicki Biggs, Natural Resource Technician for the Tribe, (209) 928-3475.

Vicki Biggs

Vicki Biggs

Natural Resource Technician

Tuolumne Me-Wuk Tribal Council

BUREAU OF INDIAN AFFAIRS CONSULTATION

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
Pacific Regional Office
2800 Cottage Way
Sacramento, California 95825

IN REPLY REFER TO

JUL 2 3 2002

Ms. Gina Ramos, Co-team Lead
Renewable Resources and Planning
Bureau of Land Management
Washington, D.C. 200240

Dear Ms. Ramos:

This is to comment on the **Bureau of Land Management (BLM) Vegetation Treatments Programmatic Environmental Impact Statement (EIS) for the Western U.S., Including Alaska** as requested in your letter dated July 3, 2002.

Regarding the BLM's proposed use of herbicides, many American Indian individuals and groups in the Pacific Region actively gather edible plants and basket-making materials from Trust lands and public lands. Edible plants are ingested of course and basket materials are usually placed in the mouth when processing, softening, or when manipulating them during the manufacturing process. These traditional practices need to be considered by the BLM when planning any herbicide treatments. Some tribes have ordinances that prohibit the use of herbicides on their lands to protect their traditional gatherers and/or plants or animals. Because the exact locations of traditional use areas are often confidential or unrecorded, it is recommended that the BLM consult with local tribes on a project by project basis when considering herbicide treatments. It is also recommended you contact the California Basket-makers Association. To obtain contact information for Federally-recognized American Indian and Alaska Native groups, please contact Ms. Daisy West at (202) 208-2475.

Thank you for the opportunity to provide comments. If you have any questions, please contact Jay Hinshaw, Forestry Branch Environmental Compliance Coordinator, at (916) 978-6021, or Ron Recker, Acting Regional Forester, at (916) 978-6065.

Sincerely,

Amy L. Dutschke

Acting Regional Director

Tribal Leaders and
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Tribal Leaders and
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Pacific Region

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Cuyapaipe Band of Mission Indians
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date:
Elizabeth DeRouen, Chairperson
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date:
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Elem Indian Colony
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact:
Term of Office - Expiration Date: **2004**
Dale A. Miller, Chairman
Elk Valley Rancheria
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Crescent City, CA 95531
Phone No: **(707) 464-4680** Fax No: **(707) 464-4519**
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date:
Harvey Angle, Chairperson
Enterprise Rancheria
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Tribal Leaders and
BIA Representatives

Pacific Region

BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact:
Term of Office - Expiration Date: **Nov 1999**
Denise Pollard, Acting Chairperson
Fort Bidwell Reservation
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Jan 2004**
Richard Wilder, Chairperson
Fort Independence Reservation
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date:
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Nov 2003**
Lorie Jaimes, Chairperson
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Feb 2002**
Dudley Burrows, Chairperson
Grindstone Rancheria
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date:
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact: **YES**
Term of Office - Expiration Date: **Jun 2003**
Clifford Lyle Marshall, Chairman
Hoopa Valley Tribal Council
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Nov 2002**
Sandra Sigala, Chairperson
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Tribal Leaders and
BIA Representatives
Pacific Region

BIA Agency Office: Southern California Agency
Self-Gov. Compact:
Term of Office - Expiration Date: Indefinite
Rebecca Osuna, Chairperson
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BIA Agency Office: Central California Agency
Self-Gov. Compact:
Term of Office - Expiration Date: Dec 2003
Kathryn Ramey, Chairperson
Ione Band of Miwok Indians
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BIA Agency Office: Central California Agency
Self-Gov. Compact:
Term of Office - Expiration Date:
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Jackson Rancheria
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BIA Agency Office: Southern California Agency
Self-Gov. Compact:
Term of Office - Expiration Date: Jul 2003
Kenneth Meza, Sr., Chairperson
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BIA Agency Office: Northern California Field Office
Self-Gov. Compact: YES
Term of Office - Expiration Date: May 2000
Alvis Johnson, Chairman
Karuk Tribe of California
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Happy Camp, CA 96039
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BIA Agency Office: Southern California Agency
Self-Gov. Compact:
Term of Office - Expiration Date: Jan 2004
Wendy Schlater, Chairperson
La Jolla Band of Luiseno Indians
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Phone No: (760) 742-3771 Fax No: (760) 742-1704
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BIA Agency Office: Southern California Agency
Self-Gov. Compact:
Term of Office - Expiration Date: Indefinite
Gwendolyn Parada, Chairperson
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BIA Agency Office: Central California Agency
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Term of Office - Expiration Date:
Vernon Wilson, Acting Chairperson
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Tribal Leaders and
BIA Representatives

Pacific Region

BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **May 2002**
Rachel Joseph, Chairperson
Lone Pine Reservation
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Dec 2002**
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BIA Agency Office: **Central California Agency**
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Term of Office - Expiration Date:
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BIA Agency Office: **Central California Agency**
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Term of Office - Expiration Date:
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BIA Agency Office: **Central California Agency**
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact: **YES**
Term of Office - Expiration Date: **2002**
Leroy J. Elliott, Chairman
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Term of Office - Expiration Date: **Jul 2006**
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Tribal Leaders and
BIA Representatives

Pacific Region

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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact.
Term of Office - Expiration Date: **2002**
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Term of Office - Expiration Date:
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Term of Office - Expiration Date: **Jan 2003**
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Term of Office - Expiration Date: **Dec 2002**
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Tribal Leaders and BIA Representatives

Pacific Region

BIA Agency Office: **Central California Agency**
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BIA Agency Office: **Central California Agency**
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact:
Term of Office - Expiration Date: **2003**
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Term of Office - Expiration Date: **Jun 2002**
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact: **YES**
Term of Office - Expiration Date:
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Tribal Leaders and
BIA Representatives

Pacific Region

BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact:
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Dec 2002**

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BIA Agency Office: **Central California Agency**
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date:

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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Apr 2003**

Deron Marquez, Chairman
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Jan 2003**

Allen E. Lawson, Jr., Chairman
San Pasqual Band of Diegueno Indians
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Self-Gov. Compact:
Term of Office - Expiration Date: **Aug 2002**

Christina Arzate, Spokesperson
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Tribal Leaders and
BIA Representatives
Pacific Region

BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
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Michael Sisco, Chairman
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Mar 2003**
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Santa Ynez Band of Mission Indians
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Dec 2002**
Ben Scerato, Chairman
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BIA Agency Office: **Central California Agency**
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Term of Office - Expiration Date:
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Jan 2003**
Nicholas H. Fonseca, Chairman
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact:
Term of Office - Expiration Date: **May 2004**
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Mar 2005**
Robert Salgado, Sr., Spokesman
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Tribal Leaders and
BIA Representatives
Pacific Region

BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Nov 2002**
Lester R. Pinola, Chairman
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact:
Term of Office - Expiration Date: **Nov 2003**
Valerie Edwards, Chairperson
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BIA Agency Office: **Southern California Agency**
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Term of Office - Expiration Date: **Dec 2002**
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact:
Term of Office - Expiration Date: **Apr 2004**
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Dec 2003**
Leanne Walker-Grant, Chairperson
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Dec 2002**
Leroy Jackson, Chairperson
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Dec 2002**
Mary E. Belardo, Chairperson
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact:
Term of Office - Expiration Date: **Apr 1998**
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Tribal Leaders and
BIA Representatives
Pacific Region

BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date:
Duane Garfield, Chairperson
Tule River Reservation
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Porterville, CA 93258
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Nov 2000**
Kevin Day, Chairperson
Tuolumne Rancheria
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Tuolumne, CA 95379
Phone No: **(209) 928-3475** Fax No: **(209) 928-1677**
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Dec 2003**
Dean Mike, Chairman
Twenty-Nine Palms Band of Mission Indians
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BIA Agency Office: **Central California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date:
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BIA Agency Office: **Southern California Agency**
Self-Gov. Compact:
Term of Office - Expiration Date: **Dec 2002**
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BIA Agency Office: **Northern California Field Office**
Self-Gov. Compact: **YES**
Term of Office - Expiration Date: **Oct 2003**
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STATE HISTORIC PRESERVATION OFFICE CONSULTATION

KSR&C No. 02-07-141

KANSAS

STATE

HISTORICAL

SOCIETY

◆

Cultural Resources Division

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KANSAS HISTORY CENTER

Administration
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Education / Outreach
Historic Sites
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HISTORIC SITES

Adair Cabin
Constitution Hall
Cottonwood Ranch
irst Territorial Capitol
Fort Hays
Goodnow House
Grinter Place
Hollenberg Station
Kaw Mission
iis des Cygnes Massacre
ine Creek Battlefield
ive American Heritage Museum
wnee Indian Village
Pawnee Rock
wnee Indian Mission

August 5, 2002

Gina Ramos
Vegetation EIS Co-Team Lead
US Department of the Interior
Bureau of Land Management
Washington, DC 20240

RE: Vegetation Treatments Programmatic EIS for Western US and Alaska
KS Statewide Projects File

Dear Ms. Ramos:

The Kansas State Historic Preservation Office (SHPO) would like to thank you for requesting our comments regarding the *Proposed Bureau of Land Management (BLM) Vegetation Treatments Programmatic Environmental Impact Statement (EIS) for the Western U.S., Including Alaska.* Because we are unaware of any Bureau of Land Management-administered lands present in the state of Kansas we do not have any concerns for implementation of the proposed vegetation treatments. The SHPO does not have any information to provide the BLM regarding resource areas, subsistence plants or animals, or traditional cultural properties within the state of Kansas of concern to Native American groups. We have chosen not to participate in the environmental process for preparation of the Vegetation EIS and do not wish to receive copies of the documents you produce.

Thank you for allowing us this opportunity to comment. If you have questions or need additional information regarding these comments, please contact Will Banks 785-272-8681 (ex. 214) or Jennifer Epperson (ex. 225).

Sincerely,

Mary R. Allman
State Historic Preservation Officer

Richard Pankratz

Richard Pankratz, Director
Historic Preservation Office

RDP/jee

WYOMING

DEPARTMENT OF STATE PARKS & CULTURAL RESOURCES
STATE HISTORIC PRESERVATION OFFICE

Barrett Building
2301 Central Ave.
Cheyenne, WY 82002

(307) 777-7697
FAX (307) 777-6421

RECEIVED
BUR. OF LAND MANAGEMENT
NEVADA STATE OFFICE
02 AUG 12 AM 7: 30

July 31, 2002

Mr. Brian Amme, Project Manager
U.S.D.I. Bureau of Land Management
Washington, D.C. 20240

RE: Bureau of Land Management (BLM) Vegetation Treatments Programmatic Environmental Impact Statement (EIS) for the Western U.S., Including Alaska; SHPO #0702RLC001

Dear: Mr. Amme,

Our staff has received information concerning the aforementioned project. Thank you for allowing us the opportunity to comment.

I am pleased that the BLM is seeking input from Native Americans concerning the effects these proposed treatments may have on resources important to them. Possessing this information prior to the development of the EIS will greatly increase the utility of this document.

There is another issue that I request the BLM analyze as part of the development of this EIS. This is an analysis of the effects of chemical vegetative treatments on organic archaeological remains (these organic remains include, but are not limited to; Carbon 14 dating samples, pollens, seeds, plant fibers, proteins, etc.). This is an issue of considerable concern, particularly the effect of "spike" and other ground penetrating chemical treatments. Addressing this issue as part of this EIS would greatly reduce concerns and confusion during the future development of project specific NEPA documents.

Please refer to SHPO project control number #0702RLC001 on any future correspondence dealing with this project. If you have any questions, contact me at 307-777-5497.

Sincerely,

Richard L. Currit

Richard L. Currit
State Historic Preservation Officer

RLC:jh

Jim Geringer, Governor   John T. Keck, Director

ENVIRONMENTAL PROTECTION AGENCY CONSULTATION

August 28, 2003

In Reply Refer To:
4000 (220)

MR 8/25/03

Dr. Tom Bailey, Chief
Environmental Protection Agency
Office of Prevention, Pesticides, and Toxic Substances
Environmental Risk Branch II
Environmental Fate and Effects Division (7505C)
Ariel Rios Building
1200 Pennsylvania Avenue, NW.
Washington, D.C. 20460

Dear Dr. Bailey:

Thank you for your Agency's comments addressing the Bureau of Land Management's (BLM) "A General Approach to the Ecological Risk Assessment (ERA) for the BLM Vegetation Treatment Environmental Impact Statement."

In May of 2002 two Toxicology Risk Assessment Teams were assembled to address both human health and ecological risks for herbicide use and practices on public lands. The teams included representatives from BLM, BLM's EIS contractor ENSR, Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and the Environmental Protection Agency (EPA). The risk assessment teams had two purposes. The first was to review current and past methodologies used for risk assessments by the BLM and other agencies, including the EPA. The other purpose was to develop a consensus on which methodologies provided the best available science and process or protocol the BLM would use to conduct future human health and ecological risk analyses for chemical herbicides proposed for use on public lands administered by the BLM.

The comments and input provided by the EPA have been invaluable in this effort. The enclosed comment sheet and final ERA document outlines where the BLM has reviewed and incorporated your agency comments. We would like to especially thank Mike Davy from your Environmental Fate and Effects Division for his assistance in helping the BLM to develop the protocol.

If you have any questions or comments, please contact Gina Ramos, National Vegetation EIS Co-Team lead, at 202-452-5084.

Sincerely,

/s/James G. Kenna (Acting)

Assistant Director, Renewable Resources and Planning

Enclosure

LLM:220 1620 LS Rm. 204:Gramos:pat:8/12/03:452-5084:EPALetter

August 28, 2003

In Reply Refer To:
4000 (220)

Solano
8-25-03

Memorandum

To: Gary Frazier
Assistant Director for Endangered Species, FWS

From: Assistant Director, Renewable Resources and Planning
Bureau of Land Management

Subject: A General Approach to the Ecological Risk Assessment (ERA) for the Bureau of Land Management (BLM) Vegetation Treatment Environmental Impact Statement (EIS)

In May 2002, two Toxicology Risk Assessment Teams were assembled to address both human health and ecological risks for herbicide use and practices on public lands. The teams included representatives from the BLM, BLM's EIS contractor ENSR, Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and the Environmental Protection Agency (EPA). The risk assessment teams had two purposes. The first was to review current and past methodologies used for risk assessments by the BLM and other agencies, including the EPA. The other purpose was to develop a consensus on which methodologies provided the best available science and process or protocol the BLM would use to conduct future human health and ecological risk analyses for chemical herbicides proposed for use on public lands administered by the BLM.

The BLM has finalized the attached ERA and will immediately start the risk assessments. The BLM will include the information from the risk assessments in the Draft EIS's Analysis section as well as in the Biological Assessment. We look forward to working with the FWS on the next phase of the EIS as well as ESA consultation. If you have any questions or comments, please contact Gina Ramos, Co-team lead at 202-452-5084.

/s/James G. Kenna (Acting)

Attachment

LLM:220 1620 LS Rm. 204:Gramos:pat:452-5084:FWSLetter

G Ramos
8-29

August 28, 2003

In Reply Refer To:
4000 (220)

Ms. Laurie K. Allen
Acting Director, NOAA
National Marine Fisheries Service
Office of Protected Resources, F/PR-3
1315 East-West Highway
Silver Spring, Maryland 20910

Dear Ms. Allen:

Thank you for your comments addressing the Bureau of Land Management's (BLM) "A General Approach to the Ecological Risk Assessment (ERA) for the BLM Vegetation Treatment Environmental Impact Statement (EIS)."

In May 2002 two Toxicology Risk Assessment Teams were assembled to address both human health and ecological risks for herbicide use and practices on public lands. The teams included representatives from the BLM, BLM's EIS contractor ENSR, Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and the Environmental Protection Agency (EPA). The risk assessment teams had two purposes. The first was to review current and past methodologies used for risk assessments by the BLM and other agencies, including the EPA. The other purpose was to develop a consensus on which methodologies provided the best available science and process or protocol the BLM would use to conduct future human health and ecological risk analyses for chemical herbicides proposed for use on public lands administered by the BLM.

The comments and input provided by NOAA have been very helpful. The enclosed comment sheet and final ERA document outlines where the BLM has reviewed and incorporated your agency comments. We would like to especially thank Kellie Foster and Rachel Friedman for their participation and assistance in helping the BLM to develop the protocol. If you have any questions or comments, please contact Gina Ramos, Co-team lead, at 202-452-5084.

Sincerely,

/s/James G. Kenna (Acting)

Assistant Director, Renewable Resources
and Planning

Enclosure
LLM:220 1620 LS Rm. 204:Gramos:pat:8/12/03:452-5084:NOAAFisheriesdoc.

U.S. FISH AND WILDLIFE SERVICE AND NOAA NATIONAL MARINE FISHERIES SERVICE CONSULTATION

Ysh
6-7-02

June 12, 2002

In Reply Refer To:
9015 (220)

Mr. Don Knowles
Director, National Marine Fisheries Service
Office of Protected Resources, F/PR3
1315 East-West Highway
Silver Spring, Maryland 20910

Dear Mr. Knowles:

On November 13, 2001, the Bureau of Land Management (BLM) met with Kellie Carter and Craig Johnson of the National Marine Fisheries Service (NMFS) and Rick Sayers and Jim Serfis of the U.S. Fish and Wildlife Service (FWS). The purpose of the meeting was to discuss the procedure for preparing a consultation agreement for the BLM's National Programmatic Environmental Impact Statement (EIS) for Vegetation Treatments. At this meeting, all three agencies agreed that the consultation would proceed according to the Section 7 Interagency Cooperation regulations at 50 CFR Part 402.

The BLM intends the national EIS to be a framework for the treatments of vegetation on BLM managed lands. Because the national EIS is broad in scope, specific details of every potential application will not be included in the EIS. Consequently, local and/or State BLM offices will still be required to conduct site specific consultations with the FWS and NMFS on actions determined to "May Affect" a listed species or adversely modify designated critical habitats.

Identification of Agency Points of Contact for the preparation of the Vegetation EIS and consultation:

Jim Serfis (FWS) and Kellie Carter (NMFS) will serve as the Points of Contacts (POC's) for their respective agencies on the Vegetation EIS. Both will also serve as team members on the EIS Interdisciplinary Team. As team members, they will provide agency input into the EIS and coordinate preparation of the Biological Opinions (BO's).

The POC's will represent their agency interests and act as the liaison to their agency staff. The BLM and ENSR International (BLM contractor) will coordinate with the POC's to develop the EIS schedule, to gather information and to contact their respective field offices for information,

and to review documents. We agreed that the POC's would attend the Vegetation EIS Interdisciplinary Team meetings and public scoping meetings whenever possible. The POC's or their representatives will also participate in conference calls and plan reviews to provide expertise regarding threatened and endangered species matters during the development of the ecological risk assessment work plan.

Initiating Consultation:

Discussions with the FWS and NMFS began on November 13, 2001. Public scoping meetings began in January 2002 and completed on March 12, 2002. After the draft public scoping report has been prepared and reviewed, the BLM, FWS, and NMFS will begin discussions to identify the "Action Area," identify potential effects to listed and proposed species and their critical habitat from the vegetation treatment methods, i.e., prescribed burning, chemical, mechanical, biological controls that will take place on BLM-managed surface lands (on a programmatic basis), identify the information needed to initiate the formal consultation process, and decide how to deal with the proposed treatment methods. These discussions will begin as soon as possible. The BLM will also develop the Preferred Alternative during this time.

The BLM will prepare an initiation package for the FWS and NMFS to begin the formal consultation process. Before preparation of the initiation package, BLM will work closely with NMFS and FWS to make the package as detailed and comprehensive as possible. Formal consultation will be initiated when the package provides all relevant data required by 50 CFR §402.14 (c) and when NMFS and FWS have received the required information. The initiation package will include the draft Biological Assessment (BA).

As part of the initiation package, the BLM will identify the effects of the proposed action on threatened, endangered, and proposed species and their critical habitat. For information on the effects of current and proposed herbicides (see attached lists of current and proposed herbicides) on threatened and endangered species, the BLM will provide FWS and NMFS information on these herbicides to the extent that the information is available to the public from the Environmental Protection Agency (EPA) and other sources, including industry. Such information may include toxic risks to listed species and fate, transport and monitoring methods to assess effectiveness of best management practices (BMP's).

When information is not available for currently approved or proposed herbicides, the BLM along with NMFS and FWS will make an assessment based on the relevant information. This information may be from studies of similar herbicides as to the likely effects to threatened and endangered species. For this EIS, the BLM will only be including those herbicides that have already received EPA labeling for range, forestry, rights of ways, and aquatic use. For those herbicides currently in use and addressed in the previous EIS's, no additional risk assessments will be prepared. Project specific consultation will rely on programmatic level risk assessments and will not require that additional, local risk assessments be prepared.

As discussed in the initial meeting, if the BLM determines that an action "May Affect" a listed species or its designated critical habitat and NMFS/FWS concur, the BLM may be able to modify the action to eliminate any adverse effects. If the BLM determines that an action is "likely to Adversely Affect" (LAA) a listed species or designated critical habitat, the BLM will attempt to modify the action to avoid such adverse effects.

To better assess the threats to listed and proposed species and their critical habitat, the BLM, FWS, and NMFS will begin discussions on the effects of the proposed action before the formal consultation stage to ensure that this information will be included in the Biological Opinion.

Initiation of formal consultation with the FWS and NMFS will occur with the release of the draft EIS. At that time, BLM will submit a final BA to the FWS and NMFS. Separate draft Biological Opinions will be completed by FWS and NMFS 135 days after formal consultation has begun, unless FWS, NMFS, and BLM mutually agree upon an extension. The BLM will review the draft Biological Opinions before the FWS and NMFS submit the final Biological Opinions. We anticipate that the final Biological Opinions will be submitted to BLM just before release of the Final EIS so that the BLM can publish the documents concurrently. The anticipated date for publication of the Biological Opinions and Final EIS is in the Summer of 2003. Both NMFS and FWS will assist BLM in reviewing the comments that BLM receives on the Draft EIS and will help BLM to develop the information to support the Final EIS. The BLM understands that if the selected alternative is not the preferred alternative, BLM will reinitiate consultation.

Information that BLM and ENSR will provide for NMFS and FWS:

The BLM intends the EIS to be a framework for the treatments of vegetation, but BLM will still require local and/or State offices to conduct site-specific consultations with the FWS and NMFS. As part of the BLM's commitment to protect listed and proposed species, the BLM will ensure that actions are not likely to jeopardize the continued existence of any listed or proposed species or result in the destruction or adverse modification of designated or proposed critical habitat. The BLM, along with assistance from NMFS and FWS, will modify the vegetation treatments in the preferred alternative to avoid the likelihood of jeopardy and adverse modification of critical habitat. Evaluation of the effects of the vegetation treatments will be to determine the "short-term harm versus the long-term good."

The Programmatic Biological Assessment will provide an overall framework for species assessments. A detailed Biological Assessment will need to be prepared for individual projects at the field office level (site-specific level analysis). The BLM will prepare an assessment for each listed species likely to be impacted by the proposed action or likely to be found in areas where vegetation treatments will occur. The BLM will provide sufficient information for each species needed to determine the effects of vegetation treatments on the species and their habitat.

Where practical, the BLM may group species based on habitat requirement or taxonomy when conducting analyses of the effect. Watersheds will identify the "action area" for some species and may be taken down to the 4th Hydrologic Unit Classification (HUC) Level.

The EIS will address threatened, endangered, and proposed species and designated and proposed critical habitat. The Biological Assessment will not address candidate species although some of these species, will be assessed in the EIS. The BLM will review State lists of threatened and endangered and sensitive species. The BLM will confer with individual States that have their own Threatened and Endangered Species Law (Oregon and California) if they require additional consultation.

Information that the BLM will gather before consultation begins and separate requirements from each agency:

The BLM understands that NMFS and FWS use the same guidance under the Endangered Species Act (ESA) for species and critical habitats. As required by NMFS, the BLM will prepare an Essential Fish Habitat Plan and coordinate the preparation of the documents with the NMFS POC and the NMFS Office of Habitat.

Timelines for EIS ID team meetings, products, reports and updates:

The BLM understands that the FWS and NMFS will provide no intermediate documents. Schedules will be coordinated with BLM and ENSR that meet the EIS schedule. The BLM will review the consultation flowchart with FWS and NMFS for any further clarification. To stay on schedule, the BLM will coordinate with the POCs for NMFS and FWS to ensure that schedules are met and to identify any problems during the informal and formal consultation process.

The BLM, FWS, and NMFS will need to closely coordinate activities throughout the EIS process to ensure that we have the Biological Opinion by the time the Final EIS is completed. Gary Frazer, Assistant Director for Endangered Species, will sign the Biological Opinion for the FWS, and Don Knowles, Director of the Office of Protected Resources, will sign the Biological Opinion for the National Marine Fisheries Service.

If you have any questions or comments concerning the EIS, please contact Gina Ramos at 202-452-5084, Brian Amme, Vegetation EIS co-team leads at 202-452-5084 or 775-862-6645, or Tim Reuwsaat, Group Manager for Resources at 202-452-5179.

Sincerely,
/s/Elena C. Daly

Assistant Director, Renewable Resources
and Planning

Enclosure

LLM:220 l620 LS Rm. 201:GRamos:452-5084:pat:6/7/02:NMFS&FWSconsultation

Currently Approved Herbicides from BLM Environmental Impact Statements

Northwest Area Noxious Weed Control Program, December 1985

2,4-D
Picloram
Dicamaba
Glyphosate (Rodeo formulation)

California Vegetation Management FEIS, August 1988

Amitrole
Asulam
Atrazine
Bromacil
2,4-D
Dalapon
Dicamba
Diuron
Fosamine
Glyphosate
Hexazinone
Picloram
Simazine
Tebuthiuron
Triclopyr

Vegetation Treatment EIS - Thirteen Western States, July 1991

Atrazine
Bromacil
Chlorsulfuron
Clopyralid
2,4–D
Dicamba
Diuron
Glyphosate
Hexazinone
Imazapyr
Mefluidide
Metsulfuron Methyl
Picloram
Simazine

Sulfometuron Methyl
Tebuthiuron
Triclopyr

Western Oregon FEIS, August 1992

Asulam
Atrazine
2,4-D
Dicamba
Glyphosate
Hexazinone
Picloram
Triclopyr

New Proposed Herbicides to be analyzed in the Vegetation EIS

Diquat
Fluridone
Imazapic
Diflufenzopyr
MCPA

August 28, 2003

In Reply Refer To:
4000 (220)

Memorandum

To: Gary Frazier
Assistant Director for Endangered Species, FWS

From: Assistant Director, Renewable Resources and Planning
Bureau of Land Management

Subject: A General Approach to the Ecological Risk Assessment (ERA) for the Bureau of Land Management (BLM) Vegetation Treatment Environmental Impact Statement (EIS)

In May 2002, two Toxicology Risk Assessment Teams were assembled to address both human health and ecological risks for herbicide use and practices on public lands. The teams included representatives from the BLM, BLM's EIS contractor ENSR, Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and the Environmental Protection Agency (EPA). The risk assessment teams had two purposes. The first was to review current and past methodologies used for risk assessments by the BLM and other agencies, including the EPA. The other purpose was to develop a consensus on which methodologies provided the best available science and process or protocol the BLM would use to conduct future human health and ecological risk analyses for chemical herbicides proposed for use on public lands administered by the BLM.

The BLM has finalized the attached ERA and will immediately start the risk assessments. The BLM will include the information from the risk assessments in the Draft EIS's Analysis section as well as in the Biological Assessment. We look forward to working with the FWS on the next phase of the EIS as well as ESA consultation. If you have any questions or comments, please contact Gina Ramos, Co-team lead at 202-452-5084.

/s/James G. Kenna (Acting)

Attachment

LLM:220 1620 LS Rm. 204:Gramos:pat:452-5084:FWSLetter

G Ramos
8-28

August 28, 2003

In Reply Refer To:
4000 (220)

Ms. Laurie K. Allen
Acting Director, NOAA
National Marine Fisheries Service
Office of Protected Resources, F/PR-3
1315 East-West Highway
Silver Spring, Maryland 20910

Dear Ms. Allen:

Thank you for your comments addressing the Bureau of Land Management's (BLM) "A General Approach to the Ecological Risk Assessment (ERA) for the BLM Vegetation Treatment Environmental Impact Statement (EIS)."

In May 2002 two Toxicology Risk Assessment Teams were assembled to address both human health and ecological risks for herbicide use and practices on public lands. The teams included representatives from the BLM, BLM's EIS contractor ENSR, Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and the Environmental Protection Agency (EPA). The risk assessment teams had two purposes. The first was to review current and past methodologies used for risk assessments by the BLM and other agencies, including the EPA. The other purpose was to develop a consensus on which methodologies provided the best available science and process or protocol the BLM would use to conduct future human health and ecological risk analyses for chemical herbicides proposed for use on public lands administered by the BLM.

The comments and input provided by NOAA have been very helpful. The enclosed comment sheet and final ERA document outlines where the BLM has reviewed and incorporated your agency comments. We would like to especially thank Kellie Foster and Rachel Friedman for their participation and assistance in helping the BLM to develop the protocol. If you have any questions or comments, please contact Gina Ramos, Co-team lead, at 202-452-5084.

Sincerely,

/s/James G. Kenna (Acting)

Assistant Director, Renewable Resources
and Planning

Enclosure
LLM:220 1620 LS Rm. 204:Gramos:pat:8/12/03:452-5084:NOAAFisheriesdoc.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

In Reply Refer to:
FWS/AES/DHCR/016804

APR 1 2004

Memorandum

To: Assistant Director –Endangered Species

From: Acting Chief, Division of Consultation, Habitat Conservation Planning, Recovery & State Grants

Subject: Consultation Agreement with BLM on the Vegetation Treatment Programmatic Environmental Impact Statement

Attached is a Consultation Agreement that describes the process that the Service and BLM will follow to complete the consultation for BLM's Vegetation Treatment program. BLM requested that we enter into the agreement to ensure an understanding of how the parties would work together and offer a timeline for the process. We worked with BLM to develop the agreement and have reviewed the document that has been finalized by BLM staff.

Please note that there are two copies to be signed and that one of the copies has been already signed by Judge Shepard. BLM staff requested that we retain the document signed by Judge Shepard and forward the document with your signature to BLM. Please let me know if you have any questions regarding the document.

Attachment

BUREAU OF LAND MANAGEMENT

and

U.S. FISH AND WILDLIFE SERVICE,

CONSULTATION AGREEMENT FOR THE

VEGETATION TREATMENTS PROGRAMMATIC

ENVIRONMENTAL IMPACT STATEMENT

A. Purpose and Need:

This Consultation Agreement (Agreement) is formulated to establish an effective and cooperative process upon which the Endangered Species Act (ESA) Section 7 Consultation may be conducted between the Bureau of Land Management (BLM), Rangelands, Soil, Water and Air Group, Washington DC, and the U.S. Fish and Wildlife Service, Region 9 Washington DC Office (Service). This Agreement addresses consultation and conferencing on all species determined to be listed as threatened or endangered, or proposed for listing, and designated or proposed critical habitat occurring on the Federal lands managed by the BLM.

This Agreement will serve to define the process, products, actions, schedule and expectations of the BLM and the Service regarding the consultation process for the *Vegetation Treatments Programmatic Environmental Impact Statement* (Vegetation Treatments EIS).

The Federal agencies will convene an interagency team composed of their employees to conduct this consultation.

B. Consultation Background:

The BLM manages 261 million acres of public land resources. BLM and its contractor, ENSR, are preparing a *Vegetation Treatments Programmatic Environmental Impact Statement* to evaluate proposed vegetation treatment methods and alternatives on lands administered by the BLM in the western continental United States and Alaska. This EIS is to serve to update the following four EISs developed by the BLM in the mid 1980s and early 1990s:

- Northwest Area Noxious Weed Control Program – 1986
- California Vegetation Management – 1988
- Vegetation Treatment of BLM Lands in Thirteen Western States – 1991
- Western Oregon Program Management of Competing Vegetation – 1992

The EIS will provide updated information and analyses provided in the earlier programmatic EISs, where necessary, to ensure that ongoing and proposed vegetation treatment methods are safe to humans and the environment and meet treatment objectives. Information provided in the EIS will help the BLM ensure that BLM vegetation treatment activities comply with applicable federal, state, local, and tribal laws, regulations, statutes, policies, and management plans.

C. Authority:

Authority to enter into this Agreement is contained in the following:

Endangered Species Act of 1973, as amended
Federal Land Policy and Management Act of 1976
Memorandum of Agreement on Endangered Species Act Section 7 Programmatic Consultation and Coordination among BLM, USDA Forest Service, NMFS, and the FWS, August 30, 2000

D. Consultation Action:

This Agreement encourages streamlining of the consultation process in the preparation of the Vegetation Treatments EIS. This increased coordination will enable the Vegetation Treatments EIS to incorporate species habitat needs and will facilitate and expedite the consultation process.

In November 2001, Informal Section 7 Consultation began with the Service on the Vegetation Treatments EIS. Formal consultation will commence when a complete written initiation request, as defined in 50 CFR 402.14 (c), including the draft Vegetation Treatments Programmatic Biological Assessment (BA) for the Draft Vegetation Treatments EIS, is received and determined to be complete by the FWS.

It is anticipated that BLM will initiate formal consultation with the Service at the time the Draft EIS is issued. The BLM will submit a draft BA as part of its consultation package. The Service will review the draft BA and notify the BLM within 30 days of any missing information in the BA. Once the draft BA is considered complete by the Service, a final BA will be prepared. The BLM will then prepare a written initiation request to start formal consultation. The Service will conduct the formal consultation within a 135-day time frame. The level of information expected in the programmatic biological consultation is unlikely to provide sufficient detail to reach conclusions that incidental take is reasonably certain to occur. Therefore, any incidental take exemptions would be deferred to site-specific consultations where sufficient detail would be available. Any request for an extension of the formal consultation period will be made by mutual agreement between BLM and the FWS.

The BA will follow the outline as found in guidance in the Endangered Species Consultation Handbook (March 1998). Anticipated environmental effects, conservation actions, mitigation, and monitoring will be disclosed in the BA. This includes analysis of direct, indirect, and interrelated and interdependent effects on listed, proposed, or candidate species, and/or designated or proposed critical habitat from the analysis of the actions in the Vegetation Treatments EIS.

E. Operations:

The BLM agrees to:

1. Appoint Ms.Gina Ramos as the primary contact regarding all BA and ESA issues and as BLM's consultation team member. If Ms. Ramos is not available, the secondary contact person is Mr. Brian Amme. Ms. Carol Spurrier will work with Ms. Ramos and Mr. Amme as necessary to facilitate consultation. If there are any unforeseeable changes in personnel, new contact person names and phone numbers will be immediately provided to the Service.

2. Prepare an assessment for each listed species that may potentially be impacted by the proposed action or likely to be found in areas where vegetation treatments would occur. The BLM will provide sufficient information for each species needed to determine the effects of vegetation treatments on the species and their habitat use. Where practical, the BLM may group species based on habitat requirement or taxonomy when conducting the affects analyses. The Programmatic BA will provide an overall framework for species assessments with a more detailed BA prepared for individual projects (site-specific level analysis).

3. Address candidate species in the BA. The BLM will review state lists of threatened and endangered and sensitive species and will confer with individual states that have their own threatened and endangered species law (Oregon and California) if they require additional consultation.

4. Will prepare an Essential Fish Habitat Plan and coordinate the preparation of the document with the Office of Habitat, NOAA Fisheries.

5. Submit recent risk assessments prepared by the BLM on chemicals that will be applied on BLM lands as part of the Vegetation Treatments EIS consultation package.

6. Submit recent risk assessments written by the FS on chemicals that will be applied on BLM lands as part of the Vegetation EIS consultation package.

7. Provide copies of the old BLM vegetation treatments EISs (as necessary), a copy of the preparation plan, and copies of relevant supporting documents as they are completed.

8. Hold meetings, conference calls, etc., as needed. If a milestone problem occurs, a conference call will be held to discuss the problem.

9. Appoint Mr. Bud Cribley and Mr. Dwight Fielder to the Division Chief/Group Manager Resolution Working Group; Appoint Mr. Ed Shepard to the Assistant Director Resolution Working Group and, Appoint Mr. Jim Hughes to the Director Resolution Working Group.

10. If there are any unforeseeable changes in personnel, new contact person names and phone numbers will be immediately provided to the FWS.

11. Provide a 90-day time frame for review of a final BA.

12. Identify all time commitments (see Attachment A). If the schedule for BLM provision of documents and other information has not been met and changes are required, changes to deadlines will not be finalized without mutual agreement with the Service on the necessary deadline changes.

The FWS agrees to:

1. Appoint Mr. Jim Serfis as the primary contact regarding all BA and ESA issues. If there are any unforeseeable changes in personnel, new contact person names and phone numbers will be immediately provided to the BLM and NOAA Fisheries.

2. Coordinate with counterpart offices for the purposes of this consultation, including identification of additional listed species list to be included in the Vegetation Treatments EIS project area.

3. Participate in milestone meetings, conference calls, etc.

4. Provide threatened and endangered species expertise to help the BLM identify conservation opportunities during preparation of the Vegetation Treatments EIS.

5. Provide a BO within the 135-day timeframe, unless extended by mutual consent.

6. Appoint Mr. Patrick Leonard to the Division Chief/Group Manager Resolution Working Group; Appoint Mr. Gary Frazer to the Assistant Director Resolution Working Group and, Appoint Mr. Clint Riley to the Director Resolution Working Group. If there are any unforeseeable changes in personnel, new contact person names and phone numbers will be immediately provided to the BLM.

7. Meet the time commitment found in Attachment A. Any scheduled changes will be made by mutual agreement.

The BLM and Service mutually agree to:

1. Provide early notification if any problems may arise that would affect the documents or timeframes.

2. Allow the primary contact personnel to make all the necessary changes to the timeframes. The Group Manager and Supervisor will only become involved if the problem becomes elevated and problem items require signatures.

3. Follow the initiation criteria as outlined in 50 402.14(c) in preparation of the initiation package.

4. Consider this as a programmatic level consultation. All Actions that could affect species will undergo consultation at the Field Office level. As part of the BLM's commitment to protect threatened and endangered species, the BLM will ensure that actions are taken to avoid a "jeopardy opinion." This is to ensure that there is continued existence of the listed species or no adverse modification of a designated critical habitat. The BLM, along with the Service, may design mitigation action for vegetation treatments that must be followed to avoid a jeopardy opinion. The focus of the intended outcome of the vegetation treatments will be to evaluate the "short term harm versus the long term good."

5. Describe a process for completing consultations at the state office and field office levels.

6. Review the comments that the BLM receives on the Draft EIS and develop the information to support the Final EIS. The BLM understands it that if the selected alternative is not the preferred alternative, BLM will reinitiate consultation.

7. Agree on effects during the informal consultation stage in order to ensure that this information will be included in the BO.

8. Coordinate as partners by mutually agreeing on conservation measures to promote recovery that will be included in the Vegetation Treatments EIS.

9. Only amend the Agreement by consensus of both parties.

10. Terminate the Agreement only if one party gives 60 day written notice.

11. Acknowledge that this Agreement is only to improve the internal management of this consultation by the BLM and the Service, and is not intended to and does not create any right or benefit, substantive or procedural, enforceable at law or equity by a party against the United states, its agencies or instrumentalities, its officers or employees, or any other person. Nothing in this Agreement shall be construed as obligating either party to the expenditure of funds, or for the future payment of money, in excess of appropriations authorized by law.

12. Recognize the use of Issue Resolution Teams (IRT) if an impasse is reached regarding any aspect of this process, Agreement, or with any of the documents. Elevations of issues to IRTs will follow these tiers: Division Chief/Group Manager Level, Assistant Director Level, and Director Level. After 15 days, the Division Chief/Group Manager level Resolution Working Group will send unresolved issues to the Assistant Director Level Resolution Working Group. If resolution cannot be achieved within 15 days at the Assistant Director Level, the issue will be elevated to the Director Level. The Director Level Issue Resolution

Working group decisions will be issued within 15 days and are the final and binding resolutions of disputes.

13. All issue resolution working group reviews should be initiated by request of the applicable working group, or a specific agency. The request will include (1) a concise summary of issues in dispute and decisions that need to be made (2) agency position statements on each of the issues (3) all supporting rationale and documentation for consideration; and (4) a brief chronology of key actions taken to resolve the dispute.

F. Term

This Agreement shall take effect upon the date of the last signature. It shall remain in effect for four years, or until the BO for the BLM Vegetation EIS is completed, whichever comes first.

G. Approved

Ed Shepard Bureau of Land Management	4/19/04 Date
Gary Frazer U.S. Fish and Wildlife Service	4/12/04 Date

Attachment A

Schedule for Document Review and Completion of Formal Consultation

Task	Due Date
BLM submit preliminary draft BA (including information on all treatment methods except use of herbicides)	November 15, 2004
Service provide BLM with comments on preliminary draft BA (less sections on herbicides)	December 31, 2004
BLM submit draft Ecological Risk Assessments to the Service	March 31, 2004
BLM submit preliminary draft BA (including sections related to use of herbicides) to Service	May 15, 2004
Service will notify BLM of any missing 50CFR 402.14(c) data in the preliminary draft BA	June 15 2004
BLM provides Service with needed information and Final BA	August 22, 2004
Service formulate draft Biological Opinion	November 20, 2004
BLM reviews draft Biological Opinion and provides comments to Service	December 5, 2004
Service prepare Final Biological Opinion	January 5, 2005

APPENDIX D

NATIVE AMERICAN AND ALASKA NATIVE RESOURCE USES

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APPENDIX D

NATIVE AMERICAN AND ALASKA NATIVE RESOURCE USES

Introduction

The U.S. Department of the Interior (USDI) Bureau of Land Management (BLM) is proposing to treat vegetation on an estimated 6 million acres annually in 17 western states, including Alaska. The purpose of this treatment is to conserve and restore vegetation, fish and wildlife habitat, and watershed function on lands administered by the BLM (public lands). Vegetation treatment methods would include mechanical, manual, chemical, and biological controls, as well as fire use.

Approximately 3.5 million acres would be treated to restore historic fire regimes and to reduce the risk of wildfire on public lands. An estimated 1.5 million acres of wildfire-damaged land would be treated annually under the Emergency Stabilization and Rehabilitation program. The rest of the acreage would be managed under several BLM programs, primarily involving the control of noxious weeds and invasive plants, improving fish and wildlife habitat, and watershed function.

The BLM is preparing a *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (PEIS) and a *Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report* (PER) to evaluate the impacts of the vegetative treatments on the environment and local economies. As part of the program, the BLM may be allowed to use several proposed herbicides that will be evaluated in the PEIS, as well as new chemicals that may be developed in the future. An assessment of the risks to humans, vegetation, fish, and wildlife from using these chemicals is currently underway. As part of the PEIS, a protocol will be developed to allow the BLM to streamline the process for evaluating and receiving approval for use of herbicides that may be developed in the future.

The BLM has important obligations to address the concerns of Native Americans and Alaska Natives about the management of land, as well as natural and cultural resources. The BLM administers nearly 262 million acres that are widely distributed throughout the West and Alaska, and that have many potential uses by Native Americans and Alaska Natives (USDI BLM 1994). A number of laws and regulations require the BLM to consider the impacts of its program on Native American and Alaska Native groups. To address the effects of the proposed treatment actions on traditionally used resources, the BLM has included Native American and Alaska Native groups in scoping meetings; coordinated with the BLM state tribal liaisons; sent consultation letters to the tribes (see Appendix C); had background research conducted on potential impacts to their uses of such resources as plants, animals, and cultural sites; and had this report on the methods and results of the work prepared.

The purpose of this report is to document the use of natural resources by Native Americans and Alaska Natives on public lands. In particular, this report focuses on the use of vegetation by these groups. The report includes a brief summary of applicable laws and regulations, and a discussion of the methods used to gather information for this report. These sections are followed by a discussion of Native American and Alaska Native concerns about how their use of plants and animals on public lands may be impacted by BLM projects.

Applicable Laws and Regulations

Federal agencies are required to consult with Native American and Alaska Native groups on projects that may impact traditional resources used by these groups. The BLM Handbook H-8160-1 *General Procedural Guidance for Native American Consultation* and the BLM Manual 8160, *Native American Coordination and Consultation*, provide guidance for consultation with native groups about land use planning and

environmental review (USDI BLM 1994). This guidance recognizes the special sovereign status of Native American tribes as well as treaty-reserved rights that some groups possess.

Several federal laws require consultation with Native Americans and Alaskan Natives. The Federal Land Policy and Management Act (FLPMA) provides the primary mechanism used by the BLM to identify places associated with traditional use, such as locations where plants and animals can be collected for cultural or religious purposes. This law requires BLM managers to involve interested parties, including native groups, when developing Resource Management Plans and plan amendments, and ensures consistency between the BLM's and the Indian tribes' land use plans.

The National Environmental Policy Act (NEPA; implementing regulations at 40 CFR Parts 1500-1508) requires the BLM to preserve important historic, cultural, and natural aspects of the nation's heritage so that environmental reviews can identify potential conflicts and seek alternatives to resolve them. Consultation for NEPA can also address concerns identified under the National Historic Preservation Act (NHPA), American Indian Religious Freedom Act (AIRFA), and Native American Graves Protection and Repatriation Act (NAGPRA) concurrently.

The NHPA requires the BLM to identify and consider the effects of its actions on properties that are listed in, or eligible for listing in, the National Register of Historic Places. These properties can include prehistoric and historic archaeological sites with cultural heritage value to native people. Also included are traditional cultural properties (TCPs), or places that are important for maintaining the continuing cultural identity of a community, and that can hold traditional cultural significance. National Park Service Bulletin 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties,* provides guidance for TCPs (Parker and King 1990). In addition, Section 800.2 of the NHPA specifies that federally recognized Indian tribes and native groups be consulted on a government-to-government basis, recognizing their sovereign status (King 2000).

The Archaeological Resources Protection Act (ARPA; implementing regulations at 43 CFR Part 7) protects archaeological sites on public lands from vandalism and requires the BLM to consult with native groups before issuing permits to excavate archaeological sites. The NAGPRA (implementing regulations at 43 CFR Part 10) requires the BLM to consult with native groups or descendants when native human remains, funerary objects, sacred objects, or objects of cultural patrimony are disturbed on federal lands.

The AIRFA established a policy of federal protection for traditional American Indian religious freedoms. It requires the BLM to review its programs and actions to avoid infringements on native traditional religious practices, including access to places and use of resources. The BLM must identify the concerns of traditional native religious practitioners relative to proposed agency actions. The Religious Freedom Restoration Act (RFRA) requires federal agencies to demonstrate "compelling governmental interest" before substantially burdening a person's religious liberty. This is a powerful standard for justifying government actions that could affect the free exercise of religions for native people. Such exercise could involve access, use, ritual practice, and other activities related to traditional religious uses of lands and resources.

Some treaties reserve rights to resource use on public land. Tribal concerns about treaty rights and treaty-protected resources will be carefully considered in BLM's planning and environmental reviews for proposed program and local projects. In addition, the Alaska Native Interest Lands Conservation Act (ANILCA) provides federal protection for subsistence hunting and fishing on federal lands in Alaska.

Methods

The BLM coordinates closely with various federal, state, and local agencies, Native American tribes, Alaska Native groups, and other stakeholders. As part of the development of the PEIS and PER, the BLM conducted public scoping to invite the public to comment on the vegetation treatments and to identify alternative treatment actions to the proposed action. Numerous comments were provided on issues related to the use and protection of natural and cultural resources used by Native Americans and Alaska Natives. These issues included protection of cultural resources, impacts on plants used for basketry, and benefits and hazards of using fire and herbicides to treat vegetation.

Among the comments expressed by the BLM specialists was the expectation that Native organizations would likely defer comments until being approached with specific local projects that involve

vegetation treatments. Other comments included the need for awareness about potential impacts on resources associated with reserved rights under treaty, where the rights exist. The liaisons also cautioned about asking the Native organizations about any confidential information because the BLM cannot base NEPA-process decisions on information that must stay outside the NEPA process.

A consultation letter was sent to Native American tribes and Alaska Native groups to initiate consultation about the vegetation treatment program (see Appendix C).

The letter asked tribal governments to review materials about the proposed vegetation treatments program that were provided with the letter, and to inform BLM officials of their concerns about any of the proposed vegetation treatments. The BLM requested information about potential impacts on subsistence plants and animals; impacts on traditional cultural properties; impacts on resources associated with reserved rights under treaty, where they exist; and which of the treatment activities were of further concern to the tribal governments. The BLM offered to provide information and review copies of the documents produced for the EIS. The BLM also noted that consultation would continue with the affected Indian tribes and Alaska Native groups during the development and implementation of special projects by BLM field offices. The responses to the letter are provided in Appendix C.

Research into the potential concerns of Indian tribes and Alaska Native groups was conducted by checking the websites of BLM state offices and a number of native groups. More general websites related to ethnobotany, such as those maintained by the U.S. Department of Agriculture National Resource Conservation Service, and available at http://plants.usda.gov/java/factSheet?cultural=yes, were also consulted. Because this line of research provided information that often was too general or related too specifically to particular locations or species, researchers reviewed the literature on the use of vegetation and other natural resources by tribes and native groups to develop the ethnographic statements.

Results

This section discusses the results of ethnographic and ethnohistoric research on Indian tribes and Alaska Native groups of the western U.S., including Alaska, which may be affected by the proposed program. Because the proposed program affects such a large region, the ethnographic summaries are generalized. Information pertaining to specific tribes and native groups should be discussed within future site-specific NEPA documents.

Concerns of Native American Tribes and Alaska Native Groups

Background research and initial tribal consultation did not reveal detailed information on the program-related concerns of Native American tribes and Alaska Native Groups. The following section summarizes some of the concerns that these groups may have about projects on public lands within their traditional territories.

The concerns of Native people are both general and specific and can include large-scale cultural heritage and traditional religious values, or such features as mountains or viewsheds as a cultural landscape. By contrast, concerns also can include very specific locations of plant, animal, and mineral resources, such as ceremonial places, sites where particular species are collected for subsistence, technical, medicinal, religious, or other ceremonial use, and archaeological sites that are important to cultural heritage.

Indian Trust Responsibilities and Rights

Federally recognized Indian tribes are considered to be sovereign governments by the United States government. They are considered to have an inherent sovereignty over their people and land, which existed prior to the formation of the U.S. government. Over four hundred treaties were signed between Indian tribes and the U.S. government, which usually gave the U.S. government large tracts of the tribe's lands; in exchange, the tribes reserved certain lands ("reservations") and their aboriginal rights over those lands. Many treaties also reserved certain rights of the tribes to access the territory outside the reservation for such activities as hunting, fishing, and plant harvesting. When dealing with tribal governments, the BLM will treat the relationship as one of government-to-government (National Environmental Justice Advisory Council 2000). It should be noted that some Indian communities are seeking federal recognition, but they are not subject to government-to-government status until they receive this recognition.

The main basis of the government-to-government relationship between the U.S. and the tribes is the U.S. government's doctrine of trust responsibility. The trust doctrine directs federal agencies to protect tribal interests as they carry out their duties. This responsibility is based on the treaties, in which the U.S. promised to protect the right of the tribes to exist on the lands that they reserved for themselves. The U.S. government also holds the legal title for much of the Indian land, in trust, for the benefit of the tribes and the tribal members. Beginning with the 1887 General Allotment Act, the U.S. government took over the role of trustee for an extensive amount of Indian land, leasing the land for logging, oil, mining, and other uses.

In some modern cases, courts have made a distinction between a "general trust responsibility" and a "specific trust responsibility." General trust responsibilities arise when an interaction between an agency and a tribe is not addressed by any specific statute, regulation, or treaty. Specific trust responsibilities are created from treaties, executive orders, and specific statutes that address the relationship between tribes and the federal government. Whether specific or general, the trust doctrine adds another obligation for agencies such as the BLM to follow while carrying out their duties (National Environmental Justice Advisory Council 2000).

Some Indian tribes have treaty-protected rights to activities and resources on public lands. The specific rights and the way in which they are exercised differ among the tribes and the BLM-administered units. Because tribes are very concerned about protecting their treaty rights to activities and resources, the potential effects of the proposed vegetation treatment program on such rights will be of great concern to the affected tribes. In general, however, native people are concerned about maintaining habitats and resources in a healthy, natural state.

Opportunities of Native Americans and Alaska Natives to Pursue Traditional Subsistence Lifeways, Practices, and Activities

Indian tribes and Alaska Native groups use lands that could receive vegetation treatments under the proposed program. This includes treaty-protected use that primarily applies to and occurs in the northwestern states. Although precise information is not available, land use is varied and includes gathering plant products, hunting, fishing, grazing livestock, visiting important places, conducting ceremonies, and teaching cultural ways to younger people. Many Native people live near their ancestral lands and feel attached to their traditional use areas, archaeological sites, and ancestors' burials. Continuing their traditional practices on the lands, visiting important places, and teaching cultural ways keep their traditions alive. The BLM recognizes the importance of Native American traditional use by providing access to lands and by considering such use in management and project planning. One example of an area where the BLM recognizes the importance of Native American use and resources is the Biscuitroot Cultural Area of Critical Environmental Concern (ACEC) in the Harney Basin of Oregon. The purpose of this ACEC is to promote and maintain traditional roots for the local tribes to harvest (Hanes 1995).

The majority of the information in this report on Native American and Alaska Native plant, animal, and mineral use is taken from reports of ethnographic observations made shortly after European, Russian, or American contact. Contemporary plant, animal, and mineral use often is not as extensive as that documented in earlier ethnographies, but in recent years there has been a rejuvenation of interest among the tribes in their traditional practices using those materials. As interest continues to grow and tribes seek access many plants, animals, and minerals that have not been sought for generations may once again be sought and collected on tribal lands, as well as BLM and other public lands. Therefore, while this report may refer to some plant, animal, and mineral use as past activities, it is recommended that the materials mentioned below be treated as if they were being used contemporarily.

Management of Vegetation by Native Americans

Native Americans and Alaska Natives have historically altered the landscape in various ways in order to increase plant production, attract and promote valued wildlife species to the area, and to produce a desired product. The deliberate use of controlled burning is probably the best-known and widely applied method of managing vegetation, although irrigation, thinning, pruning, replanting, and tilling the ground also were utilized.

Native people have used fire to promote a diversity of habitats, increasing the “edge effect” that yielded a variety and abundance of plant and animal resources. Some of the various objectives of intentional burning include: management of wild and agricultural crops; improvement of plant growth and yields; improvement of browse for game animals; fireproofing of selected areas; maintenance of prairie or grassland areas; collection of insects; management of pests; and maintenance of travel conditions (Ames and Maschner 1999, Williams 2001).

Among groups that harvested seed crops, burning often occurred immediately after seed harvest, generally from July to October, depending on the crop. In some places, the burning also was used to drive game from an area for coordinated hunting. For example, the Luiseño of California used fire not only for crop management practices, but also as a tool to conduct community rabbit drives (Bean and Shipek 1978).

In the pine-fir forests of eastern California, fires were intentionally set to promote the growth of wild seed crops, and to clear the forest floor of debris for easier hunting. Likewise, in the redwood forests of the north coast of California, the prairies bordering the forests often were burned to prevent the forest from encroaching onto the prairie, and to promote the growth of plants valuable to humans and their prey. Burning sometimes was used to clear and fertilize an area to raise tobacco, and to promote the growth of materials used in basket making (Baumhoff 1978).

Burning to promote the growth of tobacco was especially common in certain regions. A study conducted in the Great Basin revealed that tobacco was the main or secondary reason for burning among 37 of 39 groups (Doolittle 2000). Other groups manipulated tobacco using other methods. The Shasta and the Tubatulabal encouraged the growth of tobacco plants by thinning their numbers or by pruning.

Multiple groups in California and the Great Basin have planted and cultivated a wide range of crops, including tobacco, grasses, onions, root and tuber crops, and seed-bearing crops. The Cahuilla were observed planting palm trees in rows, as well as burning palm trees to kill the bugs that lived on their tops (Doolittle 2000). In the Pacific Northwest, Coast Salish people around the Puget Sound protected certain root crops by keeping the ground loose around the crops for easier digging. After harvest, the remaining plants were burned off, most likely to kill the roots of competing plants. In the Southwest, groups used various methods to increase the productivity of agricultural crops of corn, squash, and beans. Methods of soil and water control included irrigation ditches, terraces, linear grids, field borders, and check dams (Plog 1979).

Important Plant Uses and Species Used by Native Americans and Alaska Natives

Although universally important, plant use by Native American and Alaska Native groups is extremely varied, both by region and by group. Subsistence use of such plant products as roots and tubers, bark, stalks, leaves, berries, mushrooms, and nuts is essential to native people. Vegetation also provides habitat for culturally and economically important wildlife species.

Most Native American and Alaska Native groups constructed a variety of residential shelters and other buildings such as ceremonial lodges and sweat houses using a combination of materials, usually employing a locally derived hardwood as part of the structural frame. The frames were then covered with other readily available materials, such as planks, mats, bark, brush, and other materials. Wood has been carved into implements and ceremonial items, and also burned to cook food, warm dwellings, and facilitate toolmaking. Trees have been fashioned into various types of watercraft and terrestrial hauling devices, and also carved into massive ceremonial items.

The use of plants for medicinal purposes is widespread, as is the use of tobacco. Plants such as tobacco sweet grass, cedar, and sage, have seen important religious and other ceremonial uses. The use of grasses and other plant resources for basket, box, and tool making also can be observed in the cultures of numerous Native American and Alaska Native groups. Plant products also have been used to make textiles, cordage, and matting, as well as to tan hides. The use of plant dyes, paints, and soaps is widespread.

Ethnographic Overviews by State and Cultural Area

The following ethnographic overviews are organized by states and cultural area as shown in Table D-1. A culture area is a geographic region in which the tribes share many common cultural traits. In North America, there are generally considered to be 10 culture areas, of which 7 are included here (Figure D-1). It is

important to keep in mind that the contemporary borders between states did not exist in aboriginal times and has little bearing on plant and animal distributions and indigenous land use patterns and resource exploitation. Thus, there is almost no equivalence between states and culture areas; portions of most states occur in more than one culture area. For this discussion, a state having land in a particular culture area will not be discussed here as part of that culture area.

The discussions below focus on plant and animal resources traditionally used by tribal and native groups of the various regions. The BLM should consult with the specific tribes within each culture area to discuss the contemporary use of resources, since there is little documentation of current practices.

Plains

The Plains lie within the Temperate Steppe Ecoregion, also referred to as shortgrass prairie (Bailey 1995). Extending south into Texas, the region is bounded to the north by the Canadian border, to the west by the Rocky Mountains, to the east by the Great Lakes and the eastern woodlands. Plains states include portions of the states of Montana, North Dakota, South Dakota, Wyoming, Nebraska, Colorado, Oklahoma, New Mexico, and Texas. Steppe grassland vegetation dominates, with the western half of the region drier due to Rocky Mountains rain shadow affect. Historically, the shortgrass prairie supported vast herds of bison, which constituted the primary game animal for tribes inhabiting the region. Other game species included bear, antelope, elk, deer, rabbits, and birds.

Numerous human migrations have occurred in this region over the millennia, but the principal linguistic groups occupying the area included the Algonquian, Athabaskan, Caddoan, Kiowa-Tanoan, Siouan, and Uto-Aztecan. Among these groups, multiple fissions and fusions created distinct tribal entities, such as the Crow and Hidatsa Siouan groups of the northern Plains who split in the eighteenth century (Kehoe 1992). Plains tribes have had close connections to groups in other regions through direct trade or seasonal transhumance, the movement of livestock from one area to another. Groups in the southern Plains traded meat for the agricultural products of the Southwestern groups, while groups in the Great Basin (Shoshone) and Plateau (Nez Perce and others) made seasonal trips to the northern Plains to hunt bison.

Plants used by Plains groups included prairie turnip, groundnuts, ground bean, sunflower, Jerusalem artichoke, serviceberries, American lotus, sand dropseed, vine mesquite, prickly pear cactus, mesquite beans, and camas, as well as cultigens such as maize, beans, and squash (Maxwell 1978, Wedel 1983, Wedel and Frison 2001). Plants have been used for a variety of purposes. Tobacco has been smoked, sometimes in religious ceremonies. Cottonwood and willow provide fuel, as well as low quality building material. Oak, elm, and huckleberry were the best quality woods for most buildings, and the long poles of pine have been used for teepee frames. Willow also was used for boat frames that were covered with hides, while split willow shoots, box elder bark, nettles, and peeled sandbar willow have been used for baskets. A black dye derived from walnuts is used to decorate baskets. Roasted and ground mescal beans, and sweetgrass bundles have been used for medicinal purposes. Bowls and other carvings have been made from box elder; sage has been used to help whiten hides; and bows generally were made from cedar, ash, and hickory (Brown and Irwin 2001, Voget 2001, Wedel and Frison 2001, Wood and Irwin 2001).

TABLE D-1
States, Ecoregions, and Culture Areas for BLM Vegetation Treatment Areas

State	Ecoregion Division	Culture Area
Montana, North Dakota, South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, New Mexico, Texas	Temperate Steppe	Plains
Nevada, Utah, Wyoming, Oregon, Idaho, California	Temperate Desert	Great Basin
Arizona, New Mexico, Colorado, Utah, Texas, California	Subtropical Desert/Steppe	Southwest
California	Mediterranean	California
Washington, Oregon, Idaho, Montana	Temperate Desert/Steppe	Plateau
Oregon, Washington, Alaska, California	Marine/Mediterranean	Northwest Coast
Alaska	Subarctic/Tundra/Marine	Alaska

Figure D-1. Native Areas of Western North America (Washburn 1988).

Hunted animals included deer, elk, bear, mountain sheep, rabbit, antelope, and bison. Prior to equestrian culture, Indian people hunted bison by driving the animals off cliffs or into ravines. With horses, Plains groups shifted their subsistence patterns from sedentary part-time farming, plant gathering, and hunting to mounted hunting focused on the migratory herds of bison. By the late 1700s, the majority of the groups occupying the Plains kept horses, and the dependence on plants for subsistence waned (Maxwell 1978). Pressure from Europeans initially generated movements of woodland groups onto the Plains, most notably the Siouxian speakers in the 1700s.

Great Basin

This region encompasses Nevada and Utah, and includes portions of eastern California, southeastern Oregon, southern Idaho, with use areas extending into western Wyoming and Colorado. The Temperate Desert Ecoregion dominates the area, characterized by low annual rainfall and strong temperature contrasts between seasons (Bailey 1995). Elevation is a significant ecological control in both low and high deserts. This discussion focuses on the high and low desert areas, but the region's multiple Native American groups often occupy overlapping geographic zones. In the high desert vegetation is dominated by sagebrush and shadscale shrublands, with montane zones that include pinyon-juniper and ponderosa pine woodlands. The low desert includes areas of the Mojave Desert and Colorado Plateau, with expanses of sparse chenopod, yucca, and creosote; mesquite in washes; and upland stands of pinyon-juniper and oak.

A wide variety of edible plants occur throughout both the high and low desert, including grains and seeds from native amaranths, chenopods, sunflowers, ricegrass, sand dropseed, bluegrass, and wild rye and roots, bulbs or leaves of wild onion, sego lily, yellow bells, Indian potato, miner's lettuce, sweet cicely, and violets. Berries include chokecherry, currants, blue elderberry, Oregon grape, wild grape, wild rose, serviceberry, ground-cherry, and silver buffaloberry.

High Desert

Shoshone and the Northern Paiute groups occupy most of the Great Basin high desert region. Anthropologists classify the Shoshone into three groups: Northern Shoshone/Bannock, Eastern Shoshone, and Western Shoshone (Steward 1937). Prior to the acquisition of the horse in the early 1700s, family groups on the northern margin of the Great Basin fished for salmon in the spring and dug camas roots in the summer. They traveled to the mountains of southeastern Idaho and northern Utah to hunt deer and elk in the fall. After the development of equestrian culture, the group ranges and territories extended into Wyoming and Montana in seasonal pursuit of buffalo, and well into Oregon for rendezvous with Northwest tribes. An important staple throughout much of Nevada and northern Utah was the single-leaf pinõn pine nut (Murphy and Murphy 1960, Murphy 1986). Other important plant resources include chenopod, blazing star, and grass seeds; as well as southern desert species of mesquite, salvia, various cactus, and gourds (Egan 1917; Steward 1939b, 1997; Thomas et al. 1986).

The Western Shoshone territory extended from Death Valley north into northwestern Utah. They often wore hats made from twined sage bark or willow, and clothing made from bark, grass, or fur (Thomas 1986). Throughout both the high and low desert, various plants have been used for basketry, including yucca, juniper, tule, cattail, sagebrush, turkey beard, swamp grasses, Indian hemp, milkweed, cedar, cliff rose, white sage, young willow, sumac, and squaw bush (Adovasio 1986, Fowler 1986).

The Eastern Shoshone territory ranges primarily throughout an area covering the western half of Wyoming; however, the groups covered a much more extensive area when using horses to hunt buffalo (Murphy and Murphy 1960, Murphy 1986, Shimkin 1986). Elsewhere in the region, large game is relatively scarce, with regularly hunted species limited to bighorn sheep, antelope, deer, mountain lion, and wolf (Steward 1941, Pendleton and Thomas 1983, Thomas 1983). Small game and insects, which traditionally provided most of the animal protein in the diet, included rabbits, badgers, porcupines, pocket gophers, ground squirrels, prairie dogs, woodchucks, muskrats, mice, chipmunks, weasels, some reptiles and fish, owls, hawks, eagles, crows, doves, mockingbirds, sage hens, quail, waterfowl, grasshoppers, crickets, cicadas, ants, bee eggs, and larvae (Fremont 1845; Powers 1877; Egan 1917; Steward 1940, 1941, 1997; Stewart 1980; Simpson 1983).

The Northern Paiute territory ranges from southeastern Oregon to southern Nevada. Their subsistence lifestyle was very similar to that of the Western Shoshone, but with less access to low desert resources and single-leaf pinõn. A focus on important fisheries and marshes supplied chi-ui, cutthroat trout, suckers, and waterfowl (Fowler 1986).

Low Desert

A number of tribes lived in the large aboriginal territory extending from the Mojave Desert of California east onto the Colorado Plateau. Some of these tribes were the Utes, Southern Paiute, Kawaiisu, Owens Valley Paiute, and Panamint (Kehoe 1992). As with groups in the high desert, band names often were derived either from the geographical location inhabited by the band or from the primary food resource utilized by the band (Steward 1939a; Conetah 1982; Callaway et al. 1986; Janetski 1991). Generally, the seasonal migrations of the Ute and Southern Paiute involved traveling to the deserts and valleys in the winter and to the mountains in the summer. With the introduction of the horse, these groups began utilizing larger areas, including the Plains, and adopted more of the Plains cultural pattern, such as buffalo hunting and the use of long-pole tepees (Steward 1974, Conetah 1982, Janetski 1991). People at the southwestern edge of this area were far more stable, with semi-sedentary control over narrow Great Basin valleys that supported emergent horticulture. From this position, they traded west with Yokuts and Mono groups on the western side of the Sierra Nevada in California, and interacted with the mobile Great Basin groups to the north and east.

Plant species utilized by low desert bands include berries—especially buffaloberries, chokecherry, currants and gooseberries, elderberries, raspberries, serviceberries, squawberries, and strawberries—either eaten fresh or dried and stored. Roots of the sego, cat-tail, and bullrush, were collected using digging sticks, and specific gathering and processing methods developed to harvest staple foods of the single-leaf or Colorado pinõn pine nut, mesquite beans, some cactus and mescal fruit, and yucca fruit (Kelly 1964, 1976; Kelly and Fowler 1986). Jimsonweed, tobacco, nettle, and red ants are the main traditional medicines of the Kwaiisu (Zigmond 1986). The Ute were observed making cordage from sagebrush bark, juniper bark, dogbane, yucca, and nettle, while tule reeds have been used to make balsa rafts, mats, and blankets (Calloway et al. 1986). The Moapa Paiutes continue to use desert fan palms for baskets, food, and shelter (Moapa Memories 2002).

Hunted animals include deer, bears, mountain lions, coyotes, foxes, wildcats, porcupines, beavers, marmots, and badgers. Additional smaller animals and insects utilized by the low desert groups include rock squirrels, prairie dogs, squirrels, chipmunks, wood rats, mice, gophers, ducks, flickers, mourning doves, sage hens, wild turkeys, quail, owls, eagles, bird eggs, fish, lizards, snakes, locusts, ant larvae, and caterpillars (Kelly 1976, Kelly and Fowler 1986, Kroeber 1976, Laird 1976).

Southwest

The Southwest culture area lies within the Subtropical Steppe Ecoregion and Subtropical Desert Ecoregion, a dry area that is marked by annual water deficiency (Bailey 1995). The dominant vegetation zone of the region is desert shrub and other shrubs, with niches including barren zones, ponderosa pine forests, and pinyon-juniper forests. The region includes Arizona and New Mexico, and portions of Colorado, Utah, Texas, and California. Domestication of plants and animals has a long history among the Southwest cultures. Of particular importance were maize, beans, squash, and cotton in pre-European contact times; and fruit trees, cattle, horses, sheep, and goats following Spanish entry into the region. Since Native American groups often have overlapping geographic zones, this discussion is divided into the three main groups that occupy the region.

Pueblo

The Pueblo Indians today are descendants of the cliff-dwelling Anasazi, who occupied the Four Corners area of the Southwest for at least 1,500 years before the arrival of the Spanish. The Hopi of northern Arizona linguistically are Shoshonean, part of the Uto-Aztecan family that includes the Piman subgroup (Pimas and Papagos of southern Arizona) of the Sonoran branch. Zuni Pueblo in western New Mexico is unusual in that it has no linguistic relative in the Southwest, but has developed over the same period. The seven Keresan pueblos, extending from west-central New Mexico to the Rio Grande, also are a linguistic isolate. Eleven of the remaining Rio Grande pueblos speak one of three branches of the Tanoan language. While linguistically variable, the Pueblos developed quite similar settlement and subsistence patterns and cultures through time. They are most recognized for living in stair-stepped adobe structures and being excellent farmers at the time of contact, patterns that continue today.

The people of the Pueblos probably are best known for their agricultural development of corn, beans, and squash. Corn first appeared in the region between 5,000 and 4,000 years Before Present (B.P.), but beans and squash did not appear until 2,000 B.P. It wasn't until between 1,200 and 1,000 B.P. that the majority of

the Pueblos' diet came from agricultural production (Plog 1979). Along with growing domesticated plant species, the Pueblo people also developed a seasonal gathering strategy for wild plants, which were mainly available between April and October. Green plants such as amaranth, chenopods, wild onion, wild celery, and sage were gathered along with grass seeds, roots, juniper berries, pine nuts, acorns, and walnuts. Agave, prickly pear, cholla, and other cacti also were gathered when available (Bodine 1979, Plog 1979).

A variety of other plants have been used for clothing, shelter, medicine, and other functions. Yucca fibers have been used for basket making; cotton is used for weaving; small palms such as istle or hemp have been used for blankets; yucca roots were used for hair washing; and gourds were used as containers and water ladles. More recently, some modern Pueblos have participated in the Peyote religion (Bodine 1979, Kennard 1979, Plog 1979, Schroeder 1979).

Yuman Group (Colorado River Indian Tribes)

The Yuman group is composed of the Cocopa, Quechan, Maricopa, Mohave, Walapai, Havasupai, and Yavapai. These groups live in much the same areas today as they did at the time of Spanish contact, and were likely there long before. Some of the Yuman groups living along the Colorado River and up to the Middle Gila River in Arizona traditionally have cultivated corn, squash, pumpkins, melons, beans, and cotton in the floodplains; hunted small game such as rabbits; and fished (Maxwell 1978). Important plant resources included prickly pear, saguaro, mesquite, stick-leaf, mescal, yucca, piñon nuts, walnuts, sunflower seeds, juniper berries, and sumac berries.

Housing of riverine groups traditionally consisted of roofed, open-sided ramadas in the summer and semi-subterranean wattle-and-daub or sand-covered thatch in the winter-both constructed with a post and pole framework. Upland groups living on or near the Colorado Plateau practiced agriculture in the canyons in summer, and spent the fall and winter hunting deer, antelope, bighorn sheep, and rabbit, and gathering piñon nuts, mescal or agave, and other wild plants. Housing of upland groups was similar to that of the riverine groups, but winter housing was more substantial to withstand the elements, some incorporating rock shelters or caves.

The Yuman peoples have used plants and plant products for a variety of purposes: mescal fibers to make hairbrushes, pine pitch for sealing baskets, yucca fiber for sandals, willow and juniper bark for clothing, and cactus needles for tattooing. They made bows from desert mulberry, and arrows from cane. Willow shoots, sumac twigs, devil's claw, and cottonwood have been used for basketry (Khera and Mariella 1983, Schwartz 1983).

Apacheans

The Apacheans in the Southwest include the Navajo, Chiricahua, Jicarilla, Kiowa-Apache, Lipan, Mescalero, and Western Apache. These Southern Athapaskan or Apachean-speaking tribes occupied much of eastern Arizona, portions of New Mexico around the Pueblos, southeastern Colorado, western Oklahoma, and parts of western and southern Texas. Before arriving in the Southwest about 700 years ago, most Apacheans traditionally were hunters and gatherers. Following contact with the indigenous Pueblo peoples, the Navajo readily adopted maize, bean, and squash agriculture. The Western Apache, Jicarilla, and Lipan cultivated crops less intensively, and the remaining groups did not adopt any agricultural practices. With arrival of the Spanish, the Navajo readily adopted the raising of horses, sheep, goats, and cattle, and cultivated orchards and other introduced crops. The gathering of native plants by Apacheans in various areas included agave (mescal) crowns, saguaro cactus fruit, yucca, prickly pear, mesquite beans, acorns, pinyon nuts, juniper berries, sumac berries, chokecherries, various other berries, grass seeds, wild root crops, and various greens or young plants.

Yucca roots were crushed to make shampoo, while the sap of Spanish bayonet, as well as other plants, has been used for dyes. Sourberry, Wright's willow, martinia, bata mota, and other plants have been used for basketry. At least 29 species of plants have been used for medicinal purpose. The Navajos lived in cribbed-log, dome-roofed structures called hogans, and moved summer household activities to open air ramadas, lean-tos, or less formal shades or brush enclosures. The remaining Apacheans used wickiups in mountainous areas and tepees in the plains. Hunters have sought bison on the plains, elk and bighorn sheep in the mountains, and deer, antelope, cottontail rabbit, wood rats, squirrels, and opossum in various areas. Some of the tribes also hunted various wild birds, peccary, and fish; certain furbearers were taken only for their hides.

California

California, west of the mountains, lies within the Mediterranean Ecoregion, a zone with alternating wet and dry seasons at the transition between dry desert and wet coastline (Bailey 1995). The state can be divided into three main geographic regions: coastal, Central Valley and Sierra, and southern desert. Vegetation zones within the state vary from pine and oak forests in the coastal region, oak-covered hills through much of the Central Valley, pinyon-juniper forest in the east, and cactus and shrubs in the southeastern desert. Animals figure prominently in the spiritual systems of many Native American groups from this area, but bears are especially important and many groups have a category for "bear doctors" (Willard 1995). Jimson weed has been an important component of ritual life for many California groups. Because Native American groups often utilize overlapping geographic zones and California was home to tremendous cultural diversity, this discussion covers the major geographic regions. Some groups from the northern coast region of California are generally included in the Northwest Coast culture areas, and a description of their cultural pattern is found in the section on that area.

Coastal

The wide variety of plants available along the northern and central coast of California provided for a multitude of uses, including building materials, basketry, clothing, and medicine. The redwood tree has been used for the construction of permanent dwellings and large canoes, while its bark was used for both men's and women's clothing. In areas where redwood does not grow, juniper and tule reeds often were used for shelters. Tule reeds have also been used for boats, as well as for basketry, clothing, and matting. Additional plants used for basketry include hazelnut tree shoots, beargrass, black maidenhair fern, giant fern, pine roots, and bulrush roots. Green oak galls, burned pepperwood berries, tan oak bark, and alder bark have been used to make dyes for baskets and clothing. Medicinal plants include tobacco, which has been used for recreational, spiritual, and medicinal purposes; angelica, which helps sores heal; and pepperwood leaf, which soothes toothaches. Other plant uses along the coast include ashwood for tobacco pipes, yucca for netting, and oak or alder roots for wooden plates and bowls. The Pomo were observed rubbing angelica and pepper tree leaves on their bodies before hunting (Loeb 1926).

The central and northern coastal areas provide habitat for many crustaceans, shellfish, and sea mammals, and the numerous rivers are habitat for spawning fish such as salmon, sturgeon, trout, and perch. Groups having access to a wide variety of resources in northwestern California, such as the Hupa, the Yurok, and the Karok, share many traits with the cultures of the Northwest Coast, including sedentism, high population density, social stratification, and craft specialization. Farther south, the Coast Miwok, Pomo, Costanoan, and Chumash have long exploited both the central coast marine resources and inland oak forests, where they collect acorns and hunt large and small game. Over 100 species of fish inhabit the rich kelp beds off the coast, in addition to numerous marine mammals, including whales, dolphins, sea lions, seals, and otters (Maxwell 1978). The rich intertidal zone provides shellfish such as mussels, abalones, oysters, scallops and clams.

Central Valley and Sierra

In the valleys between the Sierra and coastal mountain ranges, riparian corridors and foothills rich in oak groves provide acorns, a staple in the diet of many California tribes, along with hazelnuts, pine nuts, and buckeyes. This region also provides habitat for deer, elk, rabbit, bear, and many species of berries, bulbs, tubers, and roots. Tule growing in watersheds and marshes has been an important component of material culture, specifically for basketry, matting, dwellings, and watercraft (Levy 1978; Wallace 1978a, b). Milkweed, Indian hemp, dogbane, and inner willow bark were used for cordage and rope. Tobacco has been commonly used, and horehound is boiled and drunk for medicinal purposes.

Migrating salmon are an important food source and are smoked for year-round use. Numerous lakes and valley marshes provide habitat for migrating waterfowl such as ducks and geese. The various bands associated with Yokuts and Miwok are the principal groups who traditionally inhabited the region. These people utilize many species of fish including lake trout, chubs, perch, and suckers, as well as the occasional salmon and steelhead (Wallace 1978b). Using snares, nets, arrows, and decoys, people hunt waterfowl such as geese, ducks, and mud hens. Turtles and mussels also provide an important contribution to the aboriginal diet.

Desert

Southeast California is a desert environment that extends to the coast. Tribes such as the Cahuilla,

Serrano, Gabrielino, and Luiseño have traditionally practiced a subsistence pattern very similar to Great Basin groups. Important resources for these groups have included coastal resources, but also inland deer, rabbit, rodents, and insects, such as locusts and grubs. Additional staples of the diet include wild grass, mescal seeds, pinyon nuts, and mesquite beans, which can be ground into flour and made into cakes. (Barrows 1900, Kelly1964, Kroeber 1976).

Dwellings were constructed from a wide variety of plants, including juniper, great manzanita, greasewood, mountain oak, and mesquite, with tule, carrizo, fern, bark, or reeds often used for thatching. Tule, sumac, and squawbrush, as well as a variety of rushes and grasses, have been used for basketry, while yucca and mescal have been used for cordage. Hundreds of plants have been documented for medicinal and physical enhancement uses, including tobacco, jimson weed, wormwood, creosote, and sumac (Bean and Saubel 1972). The inner bark of willow and cottonwood trees was used for women's dresses; mescal and yucca fibers were used for clothing and sandals; and mesquite bark was used for diapers. The creosote bush and milkweed were used for adhesives, and yucca root often was used to make soap.

Plateau

The Plateau lies within the Temperate Desert and Temperate Steppe Ecoregions, and includes portions of the states of Washington, Oregon, Idaho, and Montana (Bailey 1995). The primary vegetation zone of the Plateau is sagebrush steppe, with forests of Douglas-fir and ponderosa pine existing in the mountainous zones along the periphery. Seasons are marked by hot, dry summers and cold winters. The Columbia River and its tributaries provide the major resource exploitation areas. Anthropologists divide the inhabitants of the Plateau into two main linguistic and ethnic groups: Salish and Sahaptian speakers. However, the one linguistic isolate along the northeast edge off the Plateau is the Kootenai, whose Algonquian language differentiates them from the surrounding Salish speakers.

Due to predictable and abundant annual plant and animal resources, Plateau groups have been more sedentary than groups in the Great Basin or the Plains, a characteristic shared with groups in California and the Northwest Coast. The hallmark of Plateau culture is intensive salmon fishing, which is the most significant resource in the Plateau, with massive annual migrations up the Columbia and its tributaries from spring through fall. Significant plant resources include root crops of camas, bitterroot, lomatium, balsamroot, and yellowbells. For many Plateau groups, plant resources constitute a large portion of the diet, as well as supplying shelter, clothing, basketry, medicine, and many other functions. Berries are intensively collected, and fire often has been used to maintain the production of berry patches (Chatters 1998).

Southern Plateau

The Sahaptian speakers in the southern Plateau include the Northwest Sahaptin, Northeast Sahaptin, Columbia River Sahaptin, and Nez Perce. Their non-Sahaptian speaking neighbors include the Chinook, Cayuse, Molala, and Klamath. These groups occupy the lower portion of the Columbia River and its tributaries, and the adjacent upland areas, including central, southeastern and southwestern Washington State, and north central and northeastern Oregon, including the Blue Mountains.

Traditionally, dwellings were semi-subterranean and constructed from large mats made of tule bulrushes or cattail reeds sewn together with Indian hemp (Schuster 1998). The mats were overlapped and attached to the wooden frames of lodges, constructed from lodgepole pine, cedar, or driftwood. Winters were spent in riverine villages, while the spring and summer has been a time for gathering edible plants, including camas, bitterroot, lomatium, mariposa lily, wild carrot, Indian potato, parsley, Indian celery, onion, tree lichen, hazelnuts, acorns, and pine nuts. Important berries include currants, gooseberry, dogwood, serviceberry, chokecherry, huckleberries, hawthorn berries, and strawberries (Hunn 1990, Hunn and French 1998).

Douglas-fir and ponderosa pine were the main firewood, although alder wood has been preferred for cooking or smoking salmon. Douglas-fir saplings were used for fish net poles, greasewood twigs were used for sewing needles, Indian hemp was used for fishing nets and other weaving purposes, and cattail leaves were used to weave bags. Rosewood was used in cradleboards and hung in homes to repel ghosts. Mullein, willow bark, and other plants have been used for medicinal purposes, while tobacco has been smoked in religious ceremonies (Brunton 1998, Hunn and French 1998).

Sahaptian speakers and their neighbors have traditionally gathered at prime fishing locations during

the annual salmon migrations and harvested large numbers of the fish for year-round consumption. Besides salmon, other commonly utilized fish included trout, suckers, whitefish, and sturgeon. The major hunted land mammals were bison, elk, deer, antelope, caribou, and moose. Beaver, mountain goat, gopher, bear, lynx, and wolf were hunted for food as well as for fur. Cranes, duck, geese, and eagles were valued for feathers and meat (Brunton 1998, Hunn and French 1998).

Northern Plateau

The northern Plateau is occupied by Salish-speaking groups that include the Spokane, Colville, Coeur d'Alene, Wenatchee, Sinkayuse, Chelan, Sanpoil-Nespelem, Kalispel, Pend d'Oreille, Southern Okanagan, Methow, and Flathead. The neighboring Kootenai represent a language isolate, likely Algonquian. These groups occupy the upper portions of the Columbia River and its tributaries, including north-central and northeastern Washington State, northern Idaho, and parts of Montana. While salmon has long been the major component of the subsistence pattern, salmon numbers are considerably lower in the northern Plateau. Consequently, Salish group populations are smaller and their societies generally have been less stratified and less complex than the groups occupying the southern Plateau.

Plant resources utilized by northern Plateau groups include camas, bitterroot, balsam, lily corms, prickly pear fruit, sunflower seeds, hazelnuts, mint, mushrooms, tree cambium, green shoots, and berries, especially huckleberries, chokecherries, and serviceberries (Chance 1986, Kennedy and Bouchard 1998, Miller 1998). Tule reeds and cedar bark were used for covering structures, and tule also was used for matting, bedding, and to shroud corpses. Baskets and bags have been made from birch bark, cedar bark, cedar and spruce roots, and Indian hemp, which was used for cordage. Cottonwood bark was used for underground storage casks; white pine bark was used for making canoes; willow shoot mats were used for drying salmon; and maple boughs were used for snowshoe frames. Huckleberries and the inner bark of Oregon grape have been used to make dyes for baskets, and sunflower root was used for making shampoo (Kennedy and Bouchard 1998, Miller 1998). To enhance production of usable plant material, resource habitats often were annually modified through the use of controlled burning (Ross 1998).

Hunting has played a more prominent role in Salish subsistence systems than in those of the Sahaptian groups (Kennedy and Bouchard 1998). In historic times, the Flathead Salish and their neighbors the Kootenai traveled to the Plains to hunt bison (Brunton 1998).

Northwest Coast

The Northwest Coast lies primarily within the Marine Ecoregion, a zone characterized by abundant rainfall and a narrow range of temperature fluctuation. The Northwest Coast extends from southeastern Alaska south along the Canadian coast through Washington and Oregon to northern California, with the northern portion of California lying within the Mediterranean Ecoregion (Bailey 1995). The dominant vegetation consists of cedar, spruce, hemlock, and fir forests, with redwoods present in northern California. The region's stable resident and annual maritime resources were crucial in the development of densely populated, socially stratified societies (Kehoe 1992).

In California, groups manifesting a Northwest Coast cultural pattern include the Yurok, Klamath, and Modoc. In Oregon, they include the Tillamook, Yaquina, Siletz, Alsea, Siuslaw, Lower Umpqua, Coos, and Tutuni. The Chinook have flanked the Columbia River in Oregon and Washington. The Chehalis, Quinault, Queets, Quilete, Hoh, and Makah have occupied southwest Washington and the Olympic Peninsula, while the Puget Sound area has been occupied by Salish groups such as the Snoqualmie, Snohomish, Skagit, Skykomish, Puyallup, and Nisqually. In Alaska, the Tlingit and Haida have lived on the islands and limited parts of the mainland of the southeastern portion of the state (Kehoe 1992).

The Northwest Coast supports a variety of plant food sources in many different forms. Edible ferns include bracken, sword, and lady ferns. Edible lilies, onions, camas, and other roots and rhizomes were commonly harvested. The tuber of the wapato has been found abundantly in the lower Columbia River valley. Over 40 fruits and berries have been available throughout the region, including gooseberry, salmonberry, huckleberry, elderberry, and wild strawberry. Important leaves and shoots come from salal, horsetail, ferns, stinging nettle, and salmonberry. Where available, certain types of algae, seaweed, and kelp also have been used. Available edible nuts include hazelnuts, acorns, and pine nuts. Seeds have not been highly sought out, except in the Willamette Valley and

to the south, where tarweed and wyethia were eaten (Suttles 1990).

Extensive use of forest resources is typical of Northwest Coast culture, especially western red cedar and Alaska cedar for the construction of plank houses, canoes, and a wide variety of tools, as well as for baskets, cordage, matting, clothing, and specialized ritual purposes such as totem poles and masks. Specialized tools used for woodworking include stone and hardwood drills and adzes, and planes made of mussel shell (Ames and Maschner 1999).

Sitka spruce has often been used for houses and canoes along the northern coast, and western hemlock and Douglas-fir saplings were used to construct fish weirs. Red alder was the preferred wood for carving spoons, bowls, masks, and dishes, along with big-leaf maple, Rocky Mountain maple, and Alaska cedar. The western yew was used for bows, wedges, clubs, and digging sticks. The wood of ocean spray, found south of Vancouver Island, was preferred for harpoon foreshafts, spear prongs, mat needles, and spits for drying and roasting foods (Suttles 1990).

Rope and cordage have been made from western red cedar limbs, bull kelp stipes, cedar root, spruce root, willow bark, stinging nettle fibers, and Indian hemp. Cedar roots, cattail, tule, bear grass, sedges, and grasses have been used for basketry. The versatile inner bark of red and Alaska cedar is used for baskets, mats, skirts, capes, towels, and diapers. Medicinal plants included devil's club, kinnickinnick, hogfennel, and tobacco, which was common throughout the region and cultivated in some locations (Suttles 1990).

In spite of the cultural diversity among the Northwest Coast groups, they share a remarkable degree of similarity in their material cultures (Wessen 1990). Highly sophisticated maritime adaptations and complex technologies include the use of oceangoing and other canoes and harpoons, fishnets, weirs, and fish traps (Maxwell 1978). Maritime resources used by Northwest Coast groups include salmon, halibut, cod, herring, eulachon (candlefish, an important source of oil in local diets), mussels, clams, sea urchins, whales, porpoise, seals, sea lions, and sea otter. Seabird eggs also have been an important source of food (Maxwell 1978).

Controlled burning was regularly practiced (possibly as early as 5,000 years ago in the Willamette Valley) by many groups to maintain plant product and nut-producing areas and improve game animal habitat along the coast and in some interior areas, from California to British Columbia (Ames and Maschner 1999). Other terrestrial resources include elk, deer, mountain sheep, mountain goat, beaver, marten, land otter, bear, and migrating ducks (Kehoe 1992).

Alaska

Alaska includes two major divisions, the Tundra and Subarctic Ecoregions of the Polar Domain and the Marine Ecoregion of the Humid Temperate Domain (Bailey 1995). Vegetation across this large region is varied: rugged coastline forests composed of cedar, spruce, hemlock, and fir lie south and east of Cook Inlet, boreal forest dominates the vegetation of the interior, and tundra covers the northern third of the state. Generally speaking, the Inuit (Eskimo and Aleut) inhabit the coastal areas and adjacent tundra, while Indians (Athabaskan or Tlingit) inhabit the interior forests and Southeast, although both groups have tremendous intra-cultural diversity and overlapping resource exploitation areas. Terrestrial and marine mammals and fish comprise the primary source of food for both groups, while large quantities of plant products generally are less available due to the region's short growing season. Alaska's reliable maritime resources were crucial in the development of the densely populated, socially stratified societies of Southeast Alaska (Kehoe 1992), whereas the interior has long been occupied by mobile bands of hunter-gatherers. Groups such as the Haida and Tlingit live in Southeast Alaska, but are generally considered to be part of the Northwest Coast culture area.

For the Inuit, kelp and berries have been the principal plant foods, in addition to sarana lily bulbs, wild parsnip, cranberries, lupine and anemone roots, young fireweed, wild rhubarb, mushrooms, cowslip, and the bulb of the Kamchatka fritillary. Dune grass has been used to weave baskets for storing and transporting goods as well as making mats for houses, babies' cradles, and wrapping the dead. Dried grasses were also used as wicks in lamps, coated with sea mammal oil (Kehoe 1992, Lantis 1984). Traditional Inuit shelters were semi-subterranean with rafters and flooring constructed from whale bone or driftwood. These shelters were then covered with animal skins or dried grasses, and overlain with sod (Lantis 1984). The Inuit are also known as talented wood carvers, using wood to carve bowls, plates, masks, hats, and shields.

Whales are the favored food source of the Inuit, most commonly the bowhead, gray, right, and beluga whales (Maxwell 1978). Other important maritime

resources include Steller's sea lions, killer whales, narwhals, walruses, seals, porpoises, and sea otters. Many animals from various habitats also have been hunted and harvested: terrestrial mammals such as bear, beaver, squirrels, hare, porcupine, caribou, and marmots; birds such as cormorant, albatross, coot, eider duck, and eagle, as well as bird eggs; and river and ocean dwelling animals including chum and sockeye salmon, whitefish, pike, cod, halibut, sculpin, mussels, cockles, clams, anemones, and sea urchins. Animals have been utilized for more than meat. Often, skins and organs have been used for containers, hides for clothing, shelters, and boats; and bones used to create a variety of implements.

Alaska Indians, who are Northern Athabaskan and refer to themselves as "Dene" (Kehoe 1992), have focused their subsistence activities on the vast inland caribou herds and seasonally rich fish runs. Edible plant resources of the interior include berries, fern roots, lily bulbs, mushrooms, wild onions, wild rhubarb, rose hips, and various roots (Kehoe 1992). Many berries have been harvested, including mossberry, mouseberry, bunchberry, cranberry, blueberry, red raspberry, salmonberry, and winter-berry (Snow 1981). Traditionally, portable shelters were made from moose or caribou hides stretched over wooden frames and covered with bark, sod, or spruce boughs. Birch bark continues to be used for the manufacture of many utilitarian objects, including baskets, shelters, cooking pots, and canoes. The birch wood, along with willow, has been used for bows, arrows, snowshoe frames, and other wooden tools. Spruce wood was used for arrows, and for house and canoe frames. Ropes and fishing nets were made using willow bast, nettle fibers, and spruce roots. Spruce roots have many uses including containers and other basketry, sewing thread, and twine (McClellan and Deniston 1981). Framed houses often were covered with various types of brush, moss, and bark. Berries such as the silverberry and soapberry were used as clothing adornment (Slobodin 1981).

The Dene also utilize beaver, bear, moose, mountain sheep, and caribou (Kehoe 1992). In the northern interior, Indian hunters pursue Dall sheep (Maxwell 1978) and travel to the coast to collect and trade for marine resources. Many animals in Alaska are hunted for their fur, as well as for their food potential. Major fur bearing animals include wolf, wolverine, beaver, ermine, lynx, marten, mink, muskrat, red fox, and river otter (Gillespie 1978).

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APPENDIX E

CULTURAL RESOURCES

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APPENDIX E

CULTURAL RESOURCES

Introduction

The U.S. Department of the Interior (USDI) Bureau of Land Management (BLM) is proposing to treat vegetation on an estimated 6 million acres annually in the western United States and Alaska. The purpose of these treatments is to conserve and restore vegetation, fish and wildlife habitat, and watershed function on public lands administered by the BLM (public lands). Vegetation treatment methods could include mechanical, manual, chemical, and biological control, as well as use of fire.

The vegetation treatment actions would occur on public lands administered by the BLM in Alaska, Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. The BLM is preparing a Programmatic Environmental Impact Statement (EIS) to evaluate the impacts of the vegetative treatments on the environment, which includes cultural resources.

Approximately 3.5 million acres would be treated to restore historic fire regimes and to reduce the risk of wildfire on public lands. An estimated 1.5 million acres of wildfire-damaged land would be treated annually under the Emergency Stabilization and Rehabilitation program. The rest of the acreage would be managed under several BLM programs, primarily involving the control of noxious weeds and invasive plants, improving fish and wildlife habitat, and watershed function.

The BLM is preparing a *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (PEIS) and a *Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report* (PER) to evaluate the impacts of the vegetative treatments on the environment and local economies. As part of the program, the BLM may be allowed to use several proposed herbicides that will be evaluated in the PEIS, as well as new chemicals that may be developed in the future. An assessment of the risks to humans, vegetation, fish, and wildlife from using these chemicals is currently underway. As part of the PEIS, a protocol will be developed to allow the BLM to streamline the process for evaluating and receiving approval for use of herbicides that may be developed in the future.

In this report we summarize the presence and general types of prehistoric (refers to the era before the advent of the written record and the people living in North America before European contact) and historic sites (known cultural resources) on nearly 261 million acres of public lands. In particular, this report focuses on the length of prehistoric occupation and the variety of both prehistoric and historic cultural resource types found throughout the western United States and Alaska. Archaeologists have documented that the Americas have been occupied for at least 13,000 years. Beginning in the 1500s, European and Euroamerican explorers and traders encountered descendants of the earliest Americans in what are now the western United States and Alaska. Various laws and regulations require that the BLM inventory for, and consider the impacts of, actions to prehistoric and historic cultural resources located on the lands it manages.

This report includes a brief summary of applicable legislation and regulations, and summary discussions of the five culture areas and cultural resource site types known to exist where the 17 states comprising the study area are now located. These sections are followed by a summary of cultural resource site types on public lands that may be impacted by BLM projects, a listing of references cited in the report, and a bibliography of BLM and U.S. Department of Agriculture (USDA) Forest Service cultural resource overviews or summaries.

Review of Legislation and Regulations

The BLM cultural resource management responsibilities are prescribed in various pieces of federal legislation including the National Historic Preservation Act (NHPA), the Federal Land Policy and

Management Act (FLPMA), the National Environmental Policy Act (NEPA), the American Indian Religious Freedom Act (AIRFA), the Archaeological and Historic Preservation Act (AHPA), the Archaeological Resources Protection Act (ARPA), and the Native American Graves Protection and Repatriation Act (NAGPRA). Regulations for compliance with Sections 106 and 110 of NHPA are set forth in 36 Code of Federal Regulations (CFR) 800 prepared by the President's Advisory Council on Historic Preservation and entitled "The Protection of Historic and Cultural Properties." As individual properties are located, the recorder and researcher gather sufficient information to make recommendations of eligibility for the National Register of Historic Places (National Register). Under FLPMA, the BLM is specifically mandated to protect historical, including prehistoric, resources. Internal guidance for implementing these and other laws and regulations is set forth in detail in the BLM Manual 8100 series.

According to the BLM Manual 8100 series (recently revised), the BLM is responsible for evaluating, managing, and protecting cultural resources located on lands that it manages. Cultural resources include prehistoric and historic archaeological and architectural sites or properties that are definite locations of human activity, occupation, or use identifiable through field inventory or survey, historical documentation, or oral evidence. Cultural resources also include Traditional Cultural Properties, places that are culturally significant to various ethnic groups including Native Americans and Alaska Natives, and may also include Indian sacred sites. Cultural resources may be archaeological, historic, or architectural sites, structures, or places with important public and scientific uses, and may include definite locations (sites or places) of traditional cultural or religious importance to specified social and/or cultural groups.

Executive Order 13007, *Indian Sacred Sites*, affords protection, access, use of and confidentiality for tribal spiritual places on federal lands, and authorizes federal agency field managers to provide such considerations to Indian Tribes, as outline in USDI Department Manual, Part 512, Chapter 3 (*Department Responsibilities for Protecting/Accommodating Access to Indian Sacred Sites*).

The PER and PEIS are designed to look at the broad impacts associated with implementing the vegetation treatment program. Because the program covers such a large area, it is not realistic to assess site-specific impacts in the PER and PEIS. This approach will allow future development of site-specific NEPA documents, such as land-use plans and project-specific environmental analyses, thereby eliminating the need for repetitive discussions of the same issues in the site-specific documents.

Prehistoric Culture Area Summaries and Associated Cultural Resource Site Types

Given the broad coverage of the area being addressed in the current PEIS, summary cultural resources data are presented using the culture area approach. Table E-1 illustrates the correlation between states, culture areas, and, as closely as possible, ecoregion divisions. Throughout the twentieth century, anthropologists and archaeologists defined and refined the Native culture areas of North America. The discussions by culture area divisions in this section generally follow those currently accepted and presented by professional anthropologists and archaeologists in the twenty-volume *Handbook of North American Indians* (Sturtevant 1978-2001).

A culture area is a geographic region in which the tribes share many common cultural traits. Anthropologists and archaeologist generally identify 10 culture areas in North America, of which seven are included here (Figure E-1). It is important to keep in mind that the contemporary borders between states did not exist in aboriginal times and has little bearing on plant and animal distributions and indigenous land use patterns and resource exploitation. Thus, there is almost no equivalence between states and culture areas; portions of most states occur in more than one culture area.

The following summaries of prehistoric resources by culture area are further subdivided into broad time periods. The earliest time period is generally labeled as Paleoindian, the earliest cultural ancestors of the Native Americans or Indians, later encountered by historic Europeans or Euroamericans (Americans of European descent). Some archaeologists refer to Paleoindians as big game hunters, but as large mammals disappeared and the climate warmed and dried following the disappearance of major glaciers 15,000 to 10,000 BP, subsistence practices also changed. The following period from 10,000 to 6,000

TABLE E-1
States, Ecoregions, and Culture Areas for BLM Vegetation Treatment Areas

State or Portion of State	Culture Area	Ecoregion Division (Bailey 1995)
Alaska (except for Southeast Alaska)	Arctic and Subarctic	Subarctic/Tundra/Marine
Southeast Alaska, Western Washington, Western Oregon	Northwest Coast	Marine/Mediterranean
California (west of desert areas)	California	Mediterranean
Southeastern Oregon, Southern Idaho, Nevada, Western Wyoming, Western Colorado, Utah, Eastern California, Northwestern Arizona	Great Basin	Temperate Desert
Southeastern Utah, Southern Colorado, Western and Southern Texas, Arizona, New Mexico, Southeastern California	Southwest	Subtropical Desert/Steppe
Eastern Montana, North Dakota, South Dakota, Eastern Wyoming, Nebraska, Eastern Colorado, Kansas, Oklahoma, Eastern New Mexico, Central and Northern Texas	Plains	Temperate Steppe
Eastern Washington, Central and Northeastern Oregon, Northern Idaho, Western and Southwestern Montana	Plateau	Temperate Desert/Steppe

or 5,000 Before Present (BP), known as the Archaic, was a period of transition when human populations increased and exploited a broader range of animals and plant resources to survive.

In some areas the Archaic lifeway persisted until European contact, while many Native American groups throughout the western United States and Alaska generally became sedentary, settling in permanent or semi-permanent dwellings. They often settled into seasonal camps or villages, with the development of year round habitations in areas such as the Southwest and the Northwest Coast where cultural practices, such as irrigation, allowed production of crops that could be dried and stored for use throughout the year or even used over several years or abundant subsistence resources, such as salmon, could be caught, smoked and/or dried, and stored for later use or trade.

Arctic and Subarctic (Alaska)

13,000+ to 9,000 BP

One current theory among archaeologists is that the earliest human migrants, referred to as Paleoindians, crossed into the New World via the Bering Land Bridge, the area also known as Beringia. At the beginning of this period, much of Alaska was very cold windswept tundra. With huge quantities of seawater frozen in glaciers, early human migrants crossed into Alaska preying upon large herbivorous late Pleistocene (or glacial period) animals, such as mastodon, woolly mammoth, horse, and bison. Other scholarship suggests that Paleoindians may have used watercraft to move along the shoreline. A number of Paleoindian sites dating between 13,000 and 11,000 years ago are located in interior Alaska. One of the earliest archaeological sites of the period is the Mesa Site in northern Alaska, where Paleoindian projectile points were discovered atop a high, flat-topped topographic feature overlooking prime grazing lands. Other typical artifacts include lanceolate projectile points, bifacial knives and scrapers, and retouched flake tools (Ames and Maschner 1999, Dixon 1999). Based on the low density of artifacts at sites from this period, the early inhabitants of the region likely were highly mobile hunter-gatherers using short-term campsites or caves. Cultural resource sites from this time period include open campsites, habitation or campsites located in caves or rockshelters, and sites where game animals were killed and/or processed.

9,000 to 6,000 BP

As the post-glacial climate in Alaska ameliorated, prehistoric cultures became more established. Early on, many aboriginal groups maintained a similar subsistence strategy to the Paleoindians, with archaeological tool assemblages frequently dominated by microblades, small wedge-shaped cores, and specialized carving tools of stone called burins; thus, this period often is referred to as the Microblade Tradition (Dumond 1987). In addition to open campsites and sites with skin-covered tents, semi-subterranean houses are documented for this period

(Anderson 1984). Also dating to early in the period is Anangula, an extensive archaeological site located in the Aleutian Islands that represents the first sedentary population in Alaska. Out of Anangula came the Ocean Bay Tradition, a maritime-adapted culture that spread from the Aleutian Islands up the Alaskan Peninsula to Kodiak Island. Chipped stone knives, blades, and projectile points are common in Ocean Bay tool assemblages (Clark 1984). Toward the end of the period, the Northern Archaic Tradition arose in the boreal forests of the interior, represented by small, seasonal archaeological sites with artifact assemblages composed of lanceolate (spear-shaped) and side-notched projectile points and scrapers (Dumond 1987).

6,000 to 250 BP

Technological advancements during this period led to the development of several distinct cultures. The period commenced with the Arctic Small Tool Tradition, a widespread cultural phenomenon represented by tool kits that included small stone endblades and sideblades that were inserted into the shafts of arrows or spears (Dumond 1987). Other hallmark artifacts included microblades, small adz blades, and burins. Carriers of the Arctic Small Tool Tradition spread east across Alaska into Canada, hunting musk ox and other terrestrial animals, with only limited maritime hunting (Dumond 1987). However, the populations of Arctic Small Tool Tradition people who stayed in Alaska developed highly specialized maritime technologies (including kayaks, umiaks—large, open skin boats—dogsleds, toggling harpoons, bow and arrows, and ground slate tools), manifested first by the Norton Tradition and later by the Thule Tradition. In southwest Alaska, the Aleutian and Kodiak traditions developed out of Ocean Bay and refined the maritime specialization. While Kodiak Tradition artifacts were made from ground slate, artifacts of the Aleutian Tradition continued to be chipped stone (Dumond 1987). By the beginning of this period, habitations in the form of semisubterranean houses, often clustered in villages, was a common site type (McCartney 1984, Dumond 1987). In the interior, Athabaskan Indians likely descended from the earlier Northern Archaic culture (Anderson 1984).

Northwest Coast

12,500+ to 6,000 BP

The earliest indisputable evidence of human occupation on the northern Northwest Coast comes from the Ground Hog Bay 2 Site in Southeast Alaska, dating to about 11,000 BP (Ames and Maschner 1999). Early evidence for occupation of the central and southern Northwest Coast is slightly younger, dating to about 10,000 BP, though faunal remains from the Manis Mastodon site on the Olympic Peninsula suggest human presence earlier than 12,000 BP (Lyman 1991). Subsistence systems were geared toward maritime resources and typical artifacts consist of large chipped stone projectile points, microblades, compound harpoons, and grinding stones (Ames and Maschner 1999). However, due to poor preservation in this region, faunal remains and tools made from perishable items dating to this period are rarely preserved. In addition, the changing sea levels over the last 10,000 years have inundated many of the older occupation or resource processing sites in the region.

6,000 to 250 BP

By about 5,000 BP, sea levels rose and stabilized at current levels and distinctive cultural patterns emerged. Bone and ground stone tools became prevalent from Southeast Alaska to Puget Sound, as did large settlements and specialized maritime subsistence strategies. By 3,500 BP, there is evidence of sedentism based on the presence of pithouses and shell middens in western Washington, and by 3,000 BP, well-established trade networks with Plateau cultures (Nelson 1990). Archaeological sites dating to 1,000 BP indicate that by that time most Northwest Coast groups were sedentary and occupied village sites on a year-round basis. Many village sites are located for defensive purposes and often include fortifications, suggesting the presence of warfare, social complexity, and competition for resources (Ames and Maschner 1999). Typical artifacts of the period include composite woodworking tools, netsinkers, bone and antler tools, and copper and iron tools. One of the most important sites in the region is located at Ozette, on the Olympic Peninsula of Washington State. This "wet" village site typifies the Makah Indian whaling culture of approximately 500 BP. Faunal and organic remains recovered at Ozette indicate that the site was occupied year-round, and the number of well-preserved archaeological materials illustrates important socioeconomic and technological information (Wessen

1990). Unfortunately, archaeological sites in the Northwest Coast region are generally difficult to locate because of dense vegetation; in addition, the damp climate and high acidity of soil often results in the poor preservation of cultural remains, especially organic materials (Nelson 1990). Petroglyphs, designs pecked into bedrock outcrops or boulders, are estimated to be from 4,500 to 1,000 years old and are one of the better preserved and visible site types; pictographs, designs painted on bedrock, are less common (Boreson 1998, Ames and Maschner 1999).

Figure E-1. Native Areas of Western North America (after Washburn 1988).

A handful of "wet sites" occurring in the Pacific Northwest have been systematically studied, with excellent preservation of organic components, such as acorns, wood and basketry items, from prehistoric sites on the Olympic Peninsula of Washington, including Ozette, the Hoko River, Mud Bay, and the "Sunken Village" on the Willamette River in Oregon (Croes 2007).

California

11,000(?) to 8,000 BP

At the beginning of this period, climatic conditions in California were generally cool and moist. These conditions contributed to the formation of numerous pluvial (rain fed) lakes in the interior valleys and desert regions (Moratto 1984). The Lake Mojave locality, radiocarbon dated to just over 10,000 BP and representing some of the oldest archaeological materials in California, includes evidence of big game hunting with a gradual expansion in the use of plant resources. Open camp and processing sites dating to this period generally are small and rarely yield faunal remains, suggesting that early occupants of the region were few in number and maintained a highly mobile subsistence strategy. Artifacts of the period include large, fluted projectile points, leaf-shaped points, shouldered points, chipped stone crescents, scrapers, knives, and choppers (Wallace 1978).

8,000 to 5,000 BP

Between 8,000 and 7,000 BP, the warm, dry period known as the Altithermal (a period of climatic optimum) resulted in the drying of the pluvial lakes and marshes, forcing people to adapt to new environments away from the interior and toward the west (Moratto 1984). Based on the presence of milling stones at sites dating to this period, a shift from primarily big game hunting to plant and seed collecting occurred between 8,000 and 5,000 BP. Artifact assemblages are surprisingly homogeneous, consisting mostly of heavy, deep-basined milling stones, and hand stones, with projectile points, likely used with atlatls (spear-throwing sticks). Maritime resources are infrequently present within faunal assemblages in coastal midden sites. Other site types include camps and some villages in coastal areas with plentiful resources (Wallace 1978).

5,000 to 2,000 BP

Starting about 5,000 BP, a transition towards a more diversified subsistence economy that included the exploitation of marine and terrestrial resources is evident, likely related to a brief cool and wet period at the beginning of the period (Moratto 1984). Sophisticated marine adaptations were in place on the Channel Islands near Santa Barbara by about 5,000 BP, producing huge middens of shell, fish bones, and sea mammal bones (Wallace 1978, Kehoe 1992). Around the same time, inland sites located far from maritime resources show evidence of intensive plant processing, likely acorns, indicated by the presence of mortars and pestles. By about 4,000 BP, resource-rich areas such as the San Francisco Bay had relatively high population densities located in villages. The archaeological record of this period becomes more complete, indicating greater specialization and regional adaptation, including the appearance of netsinkers in artifact assemblages. Some of the recorded petroglyphs appear to correlate with similar ones from the Great Basin dating 3,000 years old, while very elaborate, perhaps ceremonial, pictographs are thought to be no more than 1,000 years old (Clelow 1978).

2,000 to 250 BP

Archaeological and climatic evidence from the last two thousand years indicates that subsistence and settlement patterns in California remained quite stable, with reliance on marine adaptations on the coast; riverine resources, especially salmon, in the north; lake and marsh resources in the central and south portions; and deer and acorns throughout the state. The presence of bedrock mortars in the Sierra Nevada foothills indicates continuous use of the same areas for long periods of time. There is also evidence for widespread burning of grasslands, brush, and forests throughout the state to stimulate plant growth and provide forage for deer, which were a universal food source (Driver and Massey 1957; Lewis 1993; Timbrook et al. 1993; Bendix 2002). The wide distribution of elaborate grave goods and trade items across the state indicates that social stratification, cultural complexity, and trade relationships developed over this period.

Great Basin

11,500+ to 8,000 BP

During the cool and moist climatic conditions of the Pleistocene, pluvial lakes and marsh environments dominated the region (Mehringer 1986). Two of the oldest sites in the region are the Tule Springs campsite, dating to 11,000 BP, and Danger Cave, which has yielded artifacts dating to as early as 9,000 BP (Aikens 1983). Typical artifacts of this period include leaf-shaped and long stemmed projectile points, occasional fluted points, specialized scrapers, chipped stone crescents, and drills (Warren and Crabtree 1986). This period also includes the earliest evidence of basket making among the culture areas presented in this report (Adovasio 1986). Sites dating to this period usually are surface scatters with no evidence of long-term use, although a number of caves have early occupations. Archaeologists conclude that inhabitants of the region were highly mobile hunter-gatherers with a generalized big game hunting and collecting economy that exploited pluvial lakeshore resources.

8,000 to 4,000 BP

The warm and dry climatic conditions of the early to mid-Holocene (the post-glacial period) were a limiting factor on human subsistence activities, with pluvial lake and marsh environments shrinking at the expense of mesic-adapted plants and shrubs (Mehringer 1986). Sites dating to this period are rare, especially in the more arid portions of the Great Basin, and include caves (Aikens 1983) and rockshelters in drier areas or pithouse villages located in valley bottoms near permanent streams and springs (Elston 1986). Although generalized hunting and collecting remained the major subsistence practices, seed gathering and processing activities gained importance, as indicated by bedrock mortars and milling stones (manos and metates). Root collecting, suggested by piles of rocks used as earth ovens, entered the subsistence economy during this period. Fishing was also gaining importance during this era, as indicated by fish weirs and net sinkers (Mehringer 1986). Typical artifacts of the period include projectile points used with atlatls, basketry, twined sandals, and various wooden implements (Aikens and Madsen 1986).

4,000 to 250 BP

By about 4,000 BP, Medithermal climatic conditions (cooling with increasing moisture leading to current conditions) prevailed across the region, yielding similar conditions to the present day (Jennings 1986). Subsistence systems continued to be very adaptive and broad spectrum; the people continued to hunt various size animals and birds and gather plant foods. Pluvial lakes and other impermanent, resource-rich areas were heavily exploited during their seasonal existence. Over time, the projectile point styles of the region shifted from larger stemmed or corner-notched points to small, corner-notched or side-notched points, indicating the adoption of the bow and arrow. While caves such as Danger Cave, Utah, continued to be occupied (Aikens 1983), many locations along major rivers contained small pithouse villages with associated storage facilities (Butler 1986). Horticulture, indicated by the presence of pottery and floral remains recovered from storage pits, was introduced in the eastern Great Basin and Owens Valley in eastern California by neighboring Southwest cultures around 1,500 BP. However, outside of these areas, hunting and gathering remained the primary subsistence practice. An expanded reliance on pinyon nut gathering became important during later times, as evidenced by mortars and pestles (Aikens and Madsen 1986, Elston 1986). Some of the earliest petroglyphs (possibly as early as 5,000 BP) are simple grooves, pits, and facets, with more definable petroglyphs by 3,000 BP and pictographs by 1,000 BP (Schaafsma 1986).

Southwest

11,500 to 8,000 BP

The earliest widespread, reliably dated archaeological materials in North America belong to the Clovis Period, documented mainly in the continental United States, and dating between 11,800 and 10,800 BP. The Clovis projectile point—a large bifacially flaked stone tool identified by a prominent "flute" or flake scar running longitudinally from the base—is the diagnostic artifact type and often demonstrates evidence of extensive reuse. Based on evidence from across North America, Paleoindian peoples likely were organized as highly mobile bands of hunter-gatherers. And while Clovis points, and the somewhat later Folsom points, traditionally have been cited as evidence of "big-game hunting," the widespread distribution of points recovered from diverse environments suggests a more generalized hunting and gathering strategy (LeTourneau 2000, Bamforth 2002).

The earliest documented complexes of the Paleoindian period, Clovis and Folsom (named after locations in the Southwest) occupied the region during a period of greater moisture than today. However, steadily decreasing moisture and erosion sequences for a few thousand years, apparently beginning earlier in this period in the western part of the region, resulted in changes in available animal and plant resources (Irwin-Williams 1979). In general, the varied environments provided numerous habitats for diverse resources, which led to subsistence patterns adapted to specific environments. Archaeological sites are generally located near now-extinct springs, large and small playas (which were Pleistocene lakes), or major drainages, and consist of open camps, animal kill sites, animal processing sites, or caves. Human groups of this period practiced a highly mobile hunting and gathering subsistence strategy.

8,000 to 2,000 BP

The beginning of this period is marked by a steady decrease of effective moisture, with a period of extreme dryness between 7,000 and 5,000 years ago, when a moderate increase in precipitation began. The later increase in precipitation in the region produced more resource-rich areas, which subsequently led to an increase in the number of archaeological sites (Irwin-Williams 1979). Archaeological sites from this period are most typically open campsites located near springs, in river valleys, along prominent streams, or along ancient lakeshores and contain chipped and ground stone tools, including manos and metates used to grind seeds. There are also rockshelter or cave sites, where well preserved twined sandals, wood artifacts, and basketry are often also recovered (Kehoe 1992). As the number of productive resource patches increased, human groups responded by engaging in a broader spectrum hunting and gathering strategies, exploiting a wider range of resources than in previous times. Horticulture was introduced into the Southwest as early as 4,500 BP, although domestic crops did not substantially contribute to the diet until later (Woodbury and Zubrow 1979). Typical artifacts of the period include stemmed projectile points used with atlatls, basketry, scrapers, grinding slabs, and cobble tools. Remains of surface structures, made of posts and brush or other material, are documented beginning midway through the period in the west, with primitive corn or maize first entering the southern part of the area (Irwin-Williams 1979). The first pit house sites and storage pits are documented late in this period (Woodbury and Zubrow 1979). Petroglyphs likely first appeared on rock outcrops and boulders by 3,000 BP with multicolor, or polychrome, abstract pictographs appearing within 500 to 1,000 years (Schaafsma 1980).

2,000 to 250 BP

Researchers subdivide the Southwestern culture area into the Anasazi, Mogollon, Hohokam, and Hakataya geographical-cultural areas (Woodbury 1979), each of which occupied distinct environmental zones and emerged around 2,000 BP. The Anasazi occupied variable topography during the generally cooler and moister periods; the Mogollon inhabited well-watered, forested and mountainous regions; the Hohokam were primarily located in low, dry deserts; and the Hakataya occupied the hot desert regions bordering the lower Colorado River (Woodbury 1979). Parts of the region were intensively occupied and socially and economically linked to the civilizations of the Mexican Classic Period, when sedentary cultures began to emerge (Irwin-Williams 1979). Archaeological recovery of minerals unique to the Southwest, specifically turquoise and malachite, in central Mexico, and copper bells, macaw feathers, and seashells imported into the Southwest from Mexico, indicate long-distance trade routes that were established during this period. Maize was cultivated in earnest by about 2,200 BP, soon followed by beans, squash, cotton, and other cultigens (Irwin-Williams 1979, Woodbury and Zubrow 1979). While the earlier hunting and gathering economy was slowly replaced by agriculture, some groups maintained mobile subsistence strategies, including seasonal bison hunts in the southern plains (Woodbury and Zubrow 1979). By 1,700 BP, some inhabitants of the region had developed sophisticated irrigation, pottery, storage pits, and pit house villages. Later, inhabitants built small to large permanent towns of multi-story, above ground structures (pueblos), often with ceremonial structures (kivas). Sites dating to this period, such as Snaketown along the Gila River of southern Arizona, often include features like irrigation canals, wells, storage pits, and roads. Typical artifacts consist of pottery (used for the storage of crop surpluses), basketry, and small corner-notched projectile points indicating the adoption of the bow and arrow by 1,500 BP (Woodbury and Zubrow 1979). Some time prior to 500 BP, various groups of Apachean speakers arrived in the Southwest region after a long journey from western Canada. While primarily mobile hunters and gatherers, at least the Navajo became semi sedentary, adopting agriculture and pottery making from the

Pueblo people. Moreover, while the Apachean habitations primarily consisted of wood or brush shelters and tepees (or pueblos among eastern groups), the Navajo often constructed cribbed log houses (hogans) and multi-room masonry structures (pueblitos; Gunnerson 1979, Brugge 1983, Young 1983).

Plains

12,000 to 8,000 BP

Human occupation of the Plains region dates to at least 11,500 BP based on radiocarbon dates for the fluted projectile points first identified at sites along Blackwater Draw near Clovis, New Mexico. The human inhabitants of the Plains responsible for the Clovis complex, and the subsequent Folsom complex, were formerly characterized as highly mobile hunters who are believed to have pursued Pleistocene megafauna (big-game) across Beringia into North America. More recent studies have concluded that the data indicate broader subsistence pursuits. Sites dating to this period vary from small campsites to large resource processing sites. They were frequently located near water sources, occupied either on a short-term basis or repeatedly over varying lengths of time, and often include finely manufactured fluted, stemmed, or lanceolate points in association with skeletons of extinct game species. The advent of “Archaic” cultural complexes and corresponding projectile point styles followed climate changes toward the end of the Pleistocene, diminution in fauna, and increased variety in available root, fruit, and seed crops coinciding with adaptation changes in human subsistence patterns and technologies.

8,000 to 2,000 BP

Bison hunting has played a significant role in the subsistence economy of Plains groups throughout prehistory, and while the climatic warming of the Altithermal altered the region's biomass productivity, human groups responded by shifting their emphasis towards the smaller *Bison bison* species. Early in the period, documented inhabitants of the northwestern, western and southern Plains maintained the highly mobile subsistence strategy of the earlier big game hunters that involved following or intercepting bison migrations across the broad region. Sites were occupied on a short-term basis, often leaving only surface scatters. Bison were often killed in large numbers using corrals or by driving the animals over cliffs, often using lines of rock cairns. Additional hunted fauna included elk, mountain sheep, deer, antelope, bear, and various small mammals, as well as fish, freshwater mussels, reptiles, and amphibians. Archaeological evidence indicates that diverse plant resources, including roots or bulbs, berries, fruits, and seeds, were collected and often processed using a variety of grinding stones. Typical artifacts of this period range from medium-sized lanceolate to large, side-notched projectile points to corner-notched dart points, along with hide scrapers, milling or grinding stones, coiled basketry, and pottery occurring toward the end of the period. While open campsites (often with fire pits), cave or rockshelter sites, and bison kill and processing sites are the most common types, burials, as well as sites containing housepits and/or food cache pits, are also documented throughout this period. In addition, the use of tepees, based on the presence of stone circles at cultural resources sites, is first documented toward the end of the period (Frison 2001, Vehik 2001).

2,000 to 250 BP

Based on the presence of small, corner-notched projectile points, the bow and arrow first appeared in the northwestern Plains about 1,900 BP. With the adoption of this new technology, hunting became more efficient. The use of tepees by the more nomadic western and northwestern Plains dwellers became very common through this period to the point where some multiple stone circle sites resemble villages. Beginning early in this time period, petroglyphs and pictographs became more common on rock outcrops in the northern and northwestern Plains and southeastern Colorado (Frison 2001, Gunnerson 2001). By 1,500 BP, farming was well established in the eastern Plains, spreading to the Middle Missouri River region by about 1,000 BP. In both areas most cultivation was confined to river valleys, as most of the rest of the region was too arid to support domesticated crops (Wedel 1961, 1983; Maxwell 1978; Kehoe 1992). Cultivated plants included maize, beans, squash, and sunflowers, which supplemented hunted fauna including bison, antelope, deer, small game, turkeys, and fish (Kehoe 1992). Early in this period occupants of the eastern Plains, Middle Missouri, and southern Plains regions lived in waddle and daub (woven wood and mud) houses, often in village arrangements along rivers or major tributaries, made pottery, and constructed burial mounds. Later in the period, the first two regions contained earth lodge villages, some of which were fortified, with numerous food storage pits

and pottery as a common artifact (Bell and Brooks 2001, Johnson 2001, Krause 2001, Wedel 2001, Wood 2001). The presence of obsidian at Kansas City sites dating to about 1,600 BP (Wedel 1983), and dentalia shells at Mandan village sites in North Dakota dating to about 600 BP, indicate the extensive trade networks connecting groups using the Yellowstone National Park area and others living in the Pacific Northwest (Kehoe 1992). Southern Plains site types include open sites, rockshelters, and both above ground dwellings and pithouses, some clustered in small villages. Subsistence initially depended on hunting and plant gathering, with horticulture variable toward the end of the period and use of bison increasing. Sometime around or after 600 BP, Apachean groups migrated from western Canada and settled in the southern Plains in open sites, sites with wattle and daub structures and tepees, or above ground, adobe structures in northeastern New Mexico (Vehik 2001).

Plateau

12,500 to 8,000 BP

With dry winters and hot summers, the arid climate of this period constricted resources to the margins of rivers and major tributaries. Occasional surface finds of fluted points and the 12,500-year-old cache of Clovis points at the Richey-Roberts site near Wenatchee, Washington, represent some of the earliest evidence of prehistoric occupation in the Plateau. Archaeological sites dating to this period include caves, rockshelters, and open camps, rarely with evidence of brush shelters; the low frequency of early sites is generally attributed to the low population densities of the highly mobile hunter-gatherers who occupied the Plateau. Stemmed and unstemmed lanceolate projectile points, microblades, cobble tools, scrapers, gravers, and bifaces are common artifacts associated with the period. Although groups engaged in fishing, intensive utilization of riverine resources did not occur until later, when climatic conditions stabilized. One exception to this is the Five Mile Rapids site where thick deposits of salmon bones and artifacts are dated at 9,000 to 10,000 years old (Ames et al. 1998; Ames and Maschner 1999).

8,000 to 4,000 BP

A gradual increase in overall moisture during this period helped expand the range of sagebrush steppe and stimulated the productivity of root crops across the region. Human groups continued to practice broad spectrum, highly mobile subsistence strategies with an increasing reliance on salmon, although evidence of food storage during this period is rare (Chatters and Pokotylo 1998). Other than addition of large side-notched points and a decrease in the overall size of projectile points—evidence of atlatl use—the tool kit is similar to that of the preceding period. Toward the end of the period, the appearance of individual or small numbers of pit houses along major drainages signals the rise of semi-sedentary settlement strategies. The presence of hopper mortars and milling stones suggest of the increased importance of roots and other plant resources in the diet. Evidence of trade in the form of glassy volcanic stone tool material and marine shell increases dramatically over the prior period (Ames et al. 1998). Other site types include large open sites lacking evidence of habitations, caves, short-term camps, resource extraction sites, and resource processing sites, generally located farther from the major drainages.

4,000 to 250 BP

Cooling climatic conditions near the beginning of this period helped to stabilize salmon productivity by restricting the seasonality of the migrations (Butler and Schalk 1986). Inhabitants of the Plateau responded by intensifying their use of salmon, storing the important resource for year-round consumption, and structuring their subsistence strategies to coincide with seasonal salmon migrations. Semi-permanent villages of pit houses of various sizes, and longhouses appearing about 1,500 BP, were located mainly along rivers and major tributaries and occupied during the winter months; some of the habitations were eventually used for human burials. Petroglyphs and pictographs, dating as early as 3,500 BP, are most common near the larger settlements such as at The Dalles on the lower Columbia River (Boreson 1998). Short-term or specialized camps positioned at strategic resource locales in the uplands and mountains were used on a seasonal basis. Storage pits contain evidence of increased use of salmon and cave sites, plus well-preserved wood and fiber artifacts. The adoption of the bow and arrow (demonstrated through a variety of small points), specialized fishing technologies (including a variety of nets, harpoons, and barbed bone points), and the continued presence of grinding and pounding tools fostered the logistics of increasingly complicated subsistence strategies. Late in the period, the introduction of the horse allowed some of the inhabitants to become highly mobile, hunting bison on the Northern Plains, and facilitated movement of

Plains material culture to the Plateau, which expanded the trade networks established in the earlier periods (Ames et al. 1998).

Historic Cultural Resource Sites and Site Types

Historic Cultural Resource Sites and Site Types

Euroamerican contact with native people, resulting in written documentation of geographic regions, cultures, and events, is generally regarded as the beginning of the historic period. Historic contacts with the western United States and Alaska generally began through exploration or trading, with missionary activities soon following in some of the land areas now managed by the BLM. The earliest exploration occurred in the Southwest and California in the 1500s, with settlements by the military, missionaries, and colonists in the 1600s in the Southwest and 1700s in California. In the late 1700s, Spanish, Russian, British, and American exploration and trade extended up and down the west coast of North America. By the late 1700s and early 1800s, explorers such as Lewis and Clark and fur traders traversed the interior of what is now the western United States (Table E-2).

The discovery and the promise of precious metals first inspired conquest of Native people through treaty and force, created the market for the development of agriculture, timber, and fisheries, and finally motivated the construction of a transportation system sufficient to transport both people and goods. In the twentieth century, the federal government reserved vast tracts of the West for management by the National Park Service, Forest Service, and, beginning in 1934 with passage of the Taylor Grazing Act, by the Grazing Service (precursor to the BLM).

This federal land has continued to sustain the mining, logging, fishing, and ranching industries. It has also been witness to military training exercises (the American military trained for both world wars and the

TABLE E-2
European and American Contact in Western North America
(Tribes indicated are representative but not inclusive)

Culture Area	Contact Date	Source
Alaska (Arctic and Subarctic)	Gradual interior expansion following first contact along the coast. First Russian trading post established on Kodiak Island 1784. Late 1700s (1790s) Russian exploration up Kuskokwim River. Around 1800, English arrive in Eastern Kutchin and northern Mackenzie River areas.	Hosley (1981)
Northwest Coast	Possibly as early as 1707 (evidence of wrecked Manila galleon off the Oregon Coast) Tlingit: 1741, Russian; 1775, Spanish Northern Coast Salish: 1792, British and Spanish Southern Coast Salish: 1792, British Kalapuyan (Willamette Valley area): 1812, Pacific Fur Company (Montreal)	De Laguna (1990), Kennedy and Bouchard (1990), Suttles (1990), Suttles and Lane (1990), Zenk (1990)
California	1542, Spanish (Cabrillo) 1579, English (Drake)	Castillo (1978)
Southwest	1540, Spanish	Ortiz (1979)
Great Basin	1770s, Spanish	Malouf and Findlay (1986)
Plains	1528-1536 (Texas), Spanish 1540-1542 (Texas and Kansas), Spanish 1659 (Northern Plains), French	Swagerty (2001)
Plateau	1600-1750, British and Spanish 1805 (Palouse), American	Sprague (1998), Walker and Sprague (1998)

Cold War on open stretches of public lands administered by the BLM) and to recreational use as increasing populations and urbanization created a higher demand for outdoor recreation (and as increased leisure time and the advent of the family car made this recreation possible).

The history of the rural West can be broadly summarized, therefore, as a chronological progression from exploration, to the discovery of mineral wealth, to wars with the Native population, to non-Indian settlement and the growth of communities dependent upon resource extraction—farming, ranching, logging, fishing, and mining. These communities were in turn linked to local, regional, and national markets through a complex and evolving system of trails, military roads, wagon roads, rail lines, and navigable river corridors, a trend that continues into the modern period. By the mid-twentieth century, with the region secured and transportation assured, recreation and tourism increasingly comprised the economic base of western communities and military training use escalated in response to the training needs of the modern military.

Public lands, encompassing the full extent of the western states, therefore contain cultural resources representing all major periods and events in the broad sweep of human history in the West. The most common rural manifestations of these dominant themes include transportation resources; military sites; mining resources related to exploration, extraction, and processing; ranching and farming resources; fishery resources; logging resources; evidence of community development; and evidence of recreation and leisure. Cultural resource types and sub-types associated with these themes are presented in Table E-3. Please note that the resource types developed prior to the establishment of the Grazing Service/BLM (1934) or those that are not directly associated with BLM administrative or permitted activities will most often be archaeological in nature. The historic site types presented below are organized by context (or theme) rather than culture area; ranching, for example, was a prominent land use on public land in both the Great Basin and the Plateau. While the details of resource types associated with this industrial process will vary from ecoregion to ecoregion, the overriding process, which in turn defines the site types, remains constant.

The specific nature of cultural resources located on public land will vary greatly based upon time of construction and/or technology employed, period of use, available building materials (e.g. adobe, log, cedar plank, milled-lumber, or sod) and the specific characteristics of local culture, climate, and geography (see Table E-1). For example, the BLM administers lands in both the deserts of the Southwest and the rainforests of the Northwest. Human response to these varied conditions and economic opportunities resulted in development of widely varied resources. This variation will prove particularly true for cultural resources associated with extraction industries, where the industrial system is defined by function and can only be understood in relationship to the specific exploited natural resource, or for cultural resources constructed prior to development of a regional transportation system, when locally available materials more completely defined vernacular architectural styles. At the state and local level, these resource-specific character-defining features are detailed in a variety of historic contexts or cultural resource management plans developed by State Historic Preservation Offices.

Cultural Resources Data Summary

Following passage of the Archaeological and Historic Preservation Act of 1974, government agencies initiated extensive cultural resource inventories of public lands. Table E-4 summarizes data by the BLM state office for total acres of land managed by BLM, the number of acres subjected to cultural resource inventories, the total cultural resource properties documented on BLM lands, and the number of properties listed in the National Register of Historic Places (National Register). It is clear from these data that while the BLM has undertaken or contracted for substantial cultural resource inventory efforts, there is still nearly 95% of public land lacking cultural resource inventories.

Many prehistoric cultural resource sites found throughout North America are quite fragile in nature and can be easily disturbed or destroyed. Table E-5 presents representative listings of prehistoric site types by culture areas and time periods from throughout the regions where vegetation treatments are planned. All cultural resource sites are non-renewable resources, hence location and evaluation of sites are important initial steps in managing cultural resources as per Sections 106 and 110 of NHPA. If sites are determined to be significant and either listed in or eligible for listing in the National Register, then the managing

TABLE E-3
Historic Site Types

Site Type	Sub Type	Culture Region
Theme: Transportation		
River navigation	▪ Fords ▪ Cable ferries ▪ Ship wrecks	All
Overland navigation (non-railroad)	▪ Trails ▪ Wagon roads (public and private) ▪ Truck trails (public and private)	All
Railroad	▪ Engineered features (bridges, trestles, ballast, track, and ties) ▪ Waste rock ▪ Construction camps (often distinguished by ethnic association)	All
Theme: Exploration and Overland Migration		
Trails (most often extant at topographic restrictions, such as ridge lines or canyons)	▪ Trail ruts (rock) ▪ Trail ruts (earth)	All
Encampment sites	Not applicable	All
Geological landmarks with cultural value and historically important viewsheds	▪ Rock promontories ▪ Springs ▪ Passes ▪ Meadows	All
Inscriptions	▪ Petroglyphs (chiseled inscriptions) ▪ Pictographs (e.g., axle grease notations) ▪ Carvings on trees	All
Missions	▪ Schools ▪ Churches ▪ Agricultural plots ▪ Orchards ▪ Housing	All
Theme: Military		
Battlefields (Indian wars)	Not applicable	All, except Alaska
Training grounds	▪ World War I era ▪ World War II/Korean War era ▪ Cold War era	Great Basin and Plateau
Transportation routes	▪ Trails ▪ Wagon roads	All
Theme: Agriculture		
Ranching	▪ Home ranch facilities (including foundations) ▪ Outlying buildings and structures ▪ Cultural landscape elements (including fences, field/pasture patterns, stock ponds and dams, stock trails, and river fords) ▪ Irrigation structures ▪ Archaeological sites	All
Farming	▪ Home ranch facilities (including foundations) ▪ Outlying buildings and structures ▪ Cultural landscape elements (including pasture patterns, stock ponds, and dams) ▪ Irrigation structures ▪ Archaeological sites	All

TABLE E-3 (Cont.)
Historic Site Types

Site Type	Sub Type	Culture Region
Theme: Commerce/Urban Development		
Urban settlement	▪ Civic ▪ Commercial ▪ Domestic	All
Theme: Mining		
Resources associated with extraction	▪ Resources associated with prospecting (locating ore), including prospect pits and trenches (hand dug and mechanically dug) ▪ Resources associated with development (accessing and removing ore from surrounding matrix) ▪ Resources associated with placer mining (sluicing and hydraulic mining dredging) ▪ Lode mining (adits, shafts, waste rock, and interior tramways)	All
Resources associated with beneficiation	▪ Mills (various types) ▪ Smelters ▪ Tailing piles ▪ Tailing ponds ▪ Power plant	All
Resources associated with refining	▪ Refineries ▪ Power plant	All
Support facilities	▪ Bunkhouses ▪ Messhalls ▪ Kitchens ▪ Livestock shelters ▪ Trash dumps ▪ Power plants	All
Transportation systems	▪ Trails ▪ Two-track roads ▪ Truck trails ▪ Rail lines ▪ Construction debris (borrow pits, and tree stumps)	All
Theme: Logging		
Extraction	▪ Stumps ▪ Skid lines ▪ Sky-line cable	All
Processing	▪ Lumber mills ▪ Power plant	All
Support facilities	▪ Shingle camps ▪ Logging camps ▪ Livestock facilities	All
Transportation	▪ Roads ▪ Donkey engines ▪ Big wheels ▪ Rail lines ▪ Cables ▪ Flumes	All

TABLE E-3 (Cont.)
Historic Site Types

Site Type	Sub Type	Culture Region
Theme: Fisheries		
Extraction (processing-related and support facilities will not be found on public land)	▪ Weirs ▪ Fish traps ▪ Natural features (falls, eddies) ▪ Boats	All
Theme: Tourism and Recreation (prior to 1934)		
Camp sites	Not applicable	All
Developed natural features	Not applicable	All
Summer homes	Not applicable	All
Interpretive signs	Not applicable	All
Transportation	▪ Roads ▪ Trails	All
Theme: BLM Administration and Development		
Administrative facilities	▪ Administration buildings ▪ Maintenance and warehouse buildings ▪ Livestock facilities ▪ Domestic buildings	All
Interpretation	▪ Museums ▪ Interpretive signs	All
Recreation (post-1934)	▪ Campground ▪ Developed water source ▪ Roads and trails	All

TABLE E-4
BLM Acreage, Cultural Resource Survey Areas, and Cultural Resources Recorded by State Office (2005)

State Offices	Number of Acres (in millions)	Number of Acres Surveyed	Percent of Acres Surveyed	Number of Properties Recorded	Number of Properties Listed in the National Register
Alaska	85.5	110,372	0.1	3,385	513
Arizona	12.2	822,100	6.7	11,858	362
California	15.2	1,813,118	11.9	28,454	1,226
Colorado	8.4	1,493,246	17.9	39,261	430
Idaho	12.0	2,020,017	16.8	14,604	827
Montana, North Dakota, South Dakota	8.3	1,340,862	16.2	10,224	37
Nevada	47.8	2,183,973	4.6	44,851	205
New Mexico, Kansas, Oklahoma, Texas	13.4	1,441,183	10.8	34,931	132
Oregon/Washington	16.5	1,585,560	9.6	12,623	98
Utah	22.9	1,801,321	7.9	38,526	556
Wyoming, Nebraska	18.4	2,590,426	14.1	40,157	83

TABLE E-5
Culture Areas, Prehistoric Occupation Periods, and Selected Common Site Types for BLM Vegetation Treatment Areas

Culture Area	Paleoindian	Middle Period or Archaic	Late or Sedentary Period
Arctic and Subarctic	*13,000+ to 9,000 BP* Open campsites Cave or rockshelter occupation sites Animal kill or processing sites Lithic processing sites	*9,000 to 6,000 BP* Open campsites Tent camps Semi-subterranean houses	*6,000 to 250 BP* Semi-subterranean house villages Open campsites Tent camps
Northwest Coast	*12,500+ to 6,000 BP* Open campsites Cave or rockshelter occupation sites		*6,000 to 250 BP.* Large, cedar plank pithouse villages Fortified sites Seafood capture or processing sites Pictograph and petroglyph sites
California	*11,000(?) to 8,000 BP* Open campsites Animal kill or processing sites	*8,000 to 5,000 BP* Open campsites Coastal villages Plant or seafood processing sites	*5,000 to 250 BP* Large coastal villages Burial mounds Extensive seafood and sea mammal processing sites Intensive plant processing sites Pictograph and petroglyph sites
Great Basin	*11,500+ to 8,000 BP* Open campsites Cave occupation sites Lithic processing sites	*8,000 to 4,000 BP* Cave or rockshelter occupation sites Pithouse villages Plant processing sites Fishing sites Lithic processing sites	*4,000 to 250 BP* Cave or rockshelter occupation sites Small pithouse villages Plant processing sites Storage pits Lithic processing sites Pictograph and petroglyph sites
Southwest	*11,500 to 8,000 BP* Open campsites Animal kill or processing sites Cave occupation sites Lithic processing sites	*8,000 to 2,000 BP* Open campsites Cave or rockshelter occupation sites Pithouses and storage pits Waddle and daub structures Lithic processing sites Pictograph and petroglyph sites	*2,000 to 250 BP* Pithouse villages Storage pits Above-ground structures (Pueblos) Below-ground structures (Kivas) Irrigation ditches Roads Navajo hogans and pueblitos Pictograph and petroglyph sites
Plains	*12,000 to 8,000 BP* Open campsites Cave or rockshelter occupation sites Animal kill or processing sites Lithic processing sites	*8,000 to 2,000 BP* Open campsites Cave or rockshelter occupation sites Pithouses and storage pits Tipi ring sites Cairns and cairn lines Animal kill or processing sites Lithic processing sites Plant processing sites	*2,000 to 250 BP* Open campsites Tipi ring sites Waddle and daub structures Earthlodge villages Burial mounds Storage pits Cave or rockshelter occupation sites Small pithouse villages Cairns and cairn lines Animal kill or processing sites Lithic processing sites Plant processing sites Pictograph and petroglyph sites

TABLE E-5 (Cont.)
Culture Areas, Prehistoric Occupation Periods, and Selected Common Site Types for BLM Vegetation Treatment Areas

Culture Area	Paleoindian	Middle Period or Archaic	Late or Sedentary Period
Plateau	*12,500 to 8,000 BP* Open campsites Cave or rockshelter occupation sites Fishing sites Lithic processing sites	*8,000 to 4,000 BP* Open campsites Small pithouse villages Cave occupation sites Animal or fish processing sites Lithic processing sites Plant processing sites	*4,000 to 250 BP* Pithouse and longhouse villages, often with burials Open campsites Cave occupation sites Storage pits Animal or fish processing sites Lithic processing sites Plant processing sites Pictograph and petroglyph sites

agency, in this case the BLM, needs to develop plans either to protect the resources or prepare and implement data recovery plans as part of the mitigation of effects from proposed undertakings or actions.

This summary presentation just begins to describe the range in age and variety of site types located on BLM-administered lands throughout the western United States and Alaska. The cultural heritage known for the various culture areas extends back 11,000 to 13,000 years before the present. As one moves forward in time, the number and variety of sites increases mainly as a result of the increase in Native populations and, after 1500 AD or so, European and Euroamerican immigration and population increase. This document indicates that a wide variety of prehistoric and historic site types are recorded on public lands and they add substantially to our knowledge of the cultural heritage of the continent. Moreover, as new sites are located and recorded, gaps in the broad picture of our cultural heritage can be filled and, through excavation of or data recovery from significant sites, our scientific knowledge can also be increased.

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APPENDIX F

SPECIAL STATUS SPECIES LIST

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SPECIAL STATUS SPECIES LIST

Common Name	Scientific Name	State	Class	Status[1]
A Caddisfly	*Farula constricta*	OR	Insect	BS
Adder's-tongue	*Ophioglossum pusillum*	OR	Plant	BS
Agave, Arizona	*Agave arizonica*	AZ	Plant	FE
Agave, Murphey	*Agave murpheyi*	AZ	Plant	BS
Agave, Santa Cruz Striped	*Agave parviflora*	AZ	Plant	BS
Agoseris, Pink	*Agoseris lackschewitzii*	ID	Plant	BS
Albatross, Short-tailed	*Phoebastris albatrus*	AK, CA	Bird	FE
Alkaligrass, Howell's	*Puccinellia howelli*	CA	Plant	BS
Alkaligrass, Lemon's	*Puccinellia lemmonii*	CA	Plant	BS
Alkaligrass, Parish's	*Puccinellia parishii*	CA, MT	Plant	BS
Alpine-aster, Tall	*Oreostemma elatum*	CA	Plant	BS
Alpine-parsley, Trotter's	*Oreoxis trotteri*	UT	Plant	BS
Alumroot, Duran's	*Heuchera duranii*	CA	Plant	BS
Amaranth, California	*Amaranthus californicus*	MT	Plant	BS
Ambersnail, Kanab	*Oxyloma haydeni kanabensis*	AZ, UT	Snail	FE
Ambrosia, San Diego	*Ambrosia pumila*	CA	Plant	FE
Amole, Purple	*Chlorogalum purpureum* var. *purpureum*	CA	Plant	FT
Amphipod, Malheur Cave	*Stygobromus hubbsi*	OR	Crustacean	BS
Amphipod, Noel's	*Gammarus desperatus*	NM	Crustacean	PE
Angelica, King's	*Angelica kingii*	ID	Plant	BS
Angelica, Rough	*Angelica scabrida*	NV	Plant	BS
Apachebush	*Apacheria chircahuensis*	NM	Plant	BS
Apple, Indian	*Peraphyllum ramosissimum*	ID	Plant	BS
Arrowhead, Sanford's	*Sagittaria sanfordii*	CA	Plant	BS
Aster, Gorman's	*Eucephalus gormanii*	OR	Plant	BS
Aster, Pygmy	*Eurybia pygmaea*	AK	Plant	BS
Aster, Red Rock Canyon	*Ionactis caelestis*	NV	Plant	BS
Avens, Mountain	*Senecio moresbiensis*	AK	Plant	BS
Baccharis, Encinitis	*Baccharis vanessae*	CA	Plant	FT
Balloonvine	*Cardiospermum corindum*	AZ	Plant	BS
Balsamroot, Big-scale	*Balsamorhiza macrolepis* var. *macrolepis*	CA	Plant	BS
Balsamroot, Large-leaved	*Balsamorhiza macrophylla*	MT	Plant	BS
Balsamroot, Silky	*Balsamorhiza sericea*	CA	Plant	BS
Balsamroot, Woolly	*Balsamorhiza hookeri* var. *lagocephala*	CA, OR	Plant	BS
Barberry, Kofa Mtn.	*Berberis harrisoniana*	AZ	Plant	BS
Barberry, Nevin's	*Mahonia nevinsii (=Berberis nevinii)*	CA	Plant	FE
Bartonberry	*Rubus bartonianus*	OR	Plant	BS
Bat, Allen's (Mexican) Big-eared	*Idionycteris phyllotis*	AZ, CO, NM, NV, UT	Mammal	BS
Bat, Big Brown	*Eptesicus fuscus*	NV	Mammal	BS
Bat, Big Free-tailed	*Nyctinomops macrotis*	CO, NM, NV, UT	Mammal	BS

Common Name	Scientific Name	State	Class	Status[1]
Bat, Brazilian Big-eared	*Tadarida brasiliensis mexicana*	UT	Mammal	BS
Bat, Brazilian Free-tailed	*Tadarida braziliensis*	NV	Mammal	BS
Bat, California Leaf-nosed	*Macrotus californicus*	AZ, CA, NV	Mammal	BS
Bat, Greater Western Mastiff	*Eumops perotis californicus*	CA, NM, NV	Mammal	BS
Bat, Hoary	*Lasiurus cinerus*	NV	Mammal	BS
Bat, Lesser Long-nosed	*Leptonycteris curosoae yerbuensis*	AZ, NM	Mammal	FE
Bat, Mexican Long-nosed	*Leptonycteris nivalis*	NM	Mammal	FE
Bat, Mexican Long-tongued	*Choernycteris mexicana*	AZ, NM	Mammal	BS
Bat, Occult Little Brown (Arizona)	*Myotis lucifugus occultus*	AZ, NM	Mammal	BS
Bat, Pale Townsend's Big-eared	*Plecotus townsendii pallescens*	NM	Mammal	BS
Bat, Pallid	*Antrozous pallidus*	CA, NV	Mammal	BS
Bat, Pocketed Free-tailed	*Nyctinomops femorosaccus*	AZ	Mammal	BS
Bat, Silver-haired	*Lasionycteris noctivagans*	NV	Mammal	BS
Bat, Spotted	*Euderma maculatum*	AZ, CA, CO, ID, MT, NM, UT, WY	Mammal	BS
Bat, Townsend's Big-eared	*Corynorhinus townsendii*	CO, NM, OR, UT	Mammal	BS
Bat, Townsend's Western Big-eared	*Corynorhinus townsendii townsendii*	CA, ID, MT, NV, OR, UT, WY	Mammal	BS
Bat, Underwood Mastiff	*Eumops underwoodi*	AZ	Mammal	BS
Bat, Western Pipistrell	*Pipistrellus hesperus*	NV	Mammal	BS
Bat, Western Red	*Lasiurus blossevillii*	NM, NV, UT	Mammal	BS
Beaked-rush, California	*Rhynchospora californica*	WY	Plant	BS
Bear, Grizzly (Brown Bear)	*Ursus arctos horribilis*	ID, MT, OR, WY	Mammal	FT
Beardtongue, Absaroka	*Penstemon absarokensis*	WY	Plant	BS
Beardtongue, Alamo	*Penstemon alamosensis*	NM	Plant	BS
Beardtongue, Bashful	*Penstemon pudicus*	NV	Plant	BS
Beardtongue, Blue-leaf	*Penstemon glaucinus*	OR	Plant	BS
Beardtongue, Broad-beard	*Penstemon angustifolius* var. *dulcis*	UT	Plant	BS
Beardtongue, Closed-throated	*Penstemon personatus*	CA	Plant	BS
Beardtongue, Cordelia	*Penstemon floribundus*	NV	Plant	BS
Beardtongue, Death Valley (Amargosa Valley Beardtongue)	*Penstemon fruticiformis* ssp. *amargosae*	CA, NV	Plant	BS
Beardtongue, Degener	*Penstemon degeneri*	CO	Plant	BS
Beardtongue, Franklin's	*Penstemon franklinii*	UT	Plant	BS
Beardtongue, Gibbens'	*Penstemon gibbensii*	CO, UT, WY	Plant	BS
Beardtongue, Goodrich's	*Penstemon goodrichii*	UT	Plant	BS
Beardtongue, Harrington	*Penstemon harringtonii*	CO	Plant	BS
Beardtongue, Mount Trumbull	*Penstemon distans*	AZ	Plant	BS
Beardtongue, Narrowleaf	*Penstemon angustifolius*	MT	Plant	BS
Beardtongue, Nevada Dune	*Penstemon arenarius*	NV	Plant	BS
Beardtongue, Pahute Mesa	*Penstemon pahutensis*	NV	Plant	BS
Beardtongue, Parachute (Parachute Penstemon)	*Penstemon debilis*	CO	Plant	C
Beardtongue, Penland	*Penstemon penlandii*	CO	Plant	FE
Beardtongue, Sand-loving	*Penstemon ammophilus*	UT	Plant	BS
Beardtongue, Sheep Range	*Penstemon petiolatus*	AZ	Plant	BS
Beardtongue, Stemless	*Penstemon acaulis*	UT, WY	Plant	BS

Common Name	Scientific Name	State	Class	Status[1]
Beardtongue, Stephen's	*Penstemon stephensii*	CA	Plant	BS
Beardtongue, Thread-leaved	*Penstemon filiformis*	CA	Plant	BS
Beardtongue, Tunnel Springs	*Penstemon concinnus*	NV	Plant	BS
Beardtongue, Uinta Basin	*Penstemon grahamii*	CO, UT	Plant	BS
Beardtongue, Uinta Basin	*Penstemon whippleanus*	MT	Plant	BS
Beardtongue, Whipple's	*Penstemon whippleanus*	MT	Plant	BS
Beardtongue, White River	*Penstemon scariosus* var. *albifluvis*	CO, UT	Plant	C
Beardtongue, White-margined	*Penstemon albomarginatus*	AZ, CA, NV	Plant	BS
Beardtongue, Yellow Two-toned	*Penstemon bicolor*	AZ	Plant	BS
Beardtongue, Yellow Two-toned	*Penstemon bicolor* ssp. *bicolor*	NV	Plant	BS
Bear-poppy, Dwarf	*Arctomecon humilis*	UT	Plant	FE
Bear-poppy, White (Merriam Bear-poppy)	*Arctomecon merriamii*	CA, NV	Plant	BS
Bear-poppy, White (Merriam Bear-poppy)	*Arctomecon merriamii*	UT	Plant	FE
Beavertail, Short-joint	*Opuntia basilaris brachyclada*	CA	Plant	BS
Bedstraw, California (San Jacinto Bedstraw)	*Galium californicum* ssp. *primum*	CA	Plant	BS
Bedstraw, El Dorado	*Galium californicum* ssp. *sierrae*	CA	Plant	FE
Bedstraw, Hardham's	*Galium hardhamiae*	CA	Plant	BS
Bedstraw, Kingston	*Galium hilendiae* ssp. *kingstonense*	CA, NV	Plant	BS
Bedstraw, Modoc	*Galium glabrescens* ssp. *modocense*	CA	Plant	BS
Bedstraw, Onyx Peak	*Galium angustifolium* ssp. *onycense*	CA	Plant	BS
Bedstraw, San Gabriel	*Galium grande*	CA	Plant	BS
Bedstraw, Scott Mountain	*Galium serpenticum* ssp. *scotticum*	CA, OR	Plant	BS
Bedstraw, Warner Mountains	*Galium serpenticum* ssp. *warnernse*	CA	Plant	BS
Bee, Mojave Gyspsum	*Andrena balsamorhiza*	NV	Insect	BS
Bee, Mojave Poppy	*Perdita meconis*	NV	Insect	BS
Beehive cactus, Santa Cruz	*Coryphantha recurvata*	AZ	Plant	BS
Beehive cactus, Scheer's	*Coryphantha scheeri* var. *scheeri*	NM	Plant	BS
Beeplant, Yellow	*Cleome lutea*	MT	Plant	BS
Beetle, American Burying	*Nicrophorus americanus*	MT, NM, WY	Insect	FE
Beetle, Blind Cave Leiodid	*Glacicavicola bathyscoides*	ID	Insect	BS
Beetle, Bruneau Dunes Tiger	*Cicindela waynei*	ID	Insect	BS
Beetle, Chiricahua Water Scavenger	*Cymbiodyta arizonica*	AZ	Insect	BS
Beetle, Ciervo Aegialian Scarab	*Aegialia concinna*	CA	Insect	BS
Beetle, Columbia River Tiger	*Cicendela columbica*	ID, OR	Insect	BS
Beetle, Coral Pink Sand Dunes	*Cicndela limbata albissima*	UT	Insect	C
Beetle, Devil's Hole Warm Spring Riffle	*Stenelmis calida calida*	NV	Insect	BS
Beetle, Large Aegilian Scarab	*Aegialia magnifica*	NV	Insect	BS
Beetle, Maricopa Tiger	*Cicindela oregona maricopa*	AZ	Insect	BS
Beetle, Moapa Warm Spring Riffle	*Stenelmis moapa*	NV	Insect	BS
Beetle, Roth's Blind Ground	*Pterostichus rothi*	OR	Insect	BS
Beetle, San Joaquin Dune	*Coelus gracilis*	CA	Insect	BS
Beetle, St. Anthony Sand Dunes Tiger	*Cicindela arenicola*	ID	Insect	BS
Beetle, Valley Elderberry Longhorn	*Desmocerus californicus dimorphus*	CA	Insect	FT
Bensoniella, Oregon	*Bensoniella oregana*	OR	Plant	BS
Bentgrass, Henderson's	*Agrostis hendersonii*	OR	Plant	BS
Bentgrass, Hoover's	*Agrostis hooveri*	CA	Plant	BS

Common Name	Scientific Name	State	Class	Status[1]
Bentgrass, Howell's	*Agrostis howelli*	OR	Plant	BS
Bicscuitroot, Clark's	*Lomatium graveolens* var. *alpinum*	NV, UT	Plant	BS
Bicscuitroot, Sanicle (Toiyabe Springparsley)	*Cymopterus goodrichii*	NV	Plant	BS
Bird's-beak, Hispid	*Cordylanthus mollis* ssp. *hispidus*	OR	Plant	BS
Bird's-beak, Pallid	*Cordylanthus tenuis* ssp. *pallescens*	CA	Plant	BS
Bird's-beak, Point Reyes	*Cordylanthus maritimus* ssp. *palustris*	OR	Plant	BS
Bird's-beak, Tecopa	*Cordylanthus tecopensis*	CA, NV	Plant	BS
Biscuitroot, Sanicle (Ripley Biscuitroot)	*Cymopterus ripleyi*	CA, NV	Plant	BS
Biscuitroot, Wideleaf	*Lomatium latilobum*	CO, UT	Plant	BS
Bittercress, Constance's	*Cardamine constancei*	ID	Plant	BS
Bittercress, Saddle Mountain	*Cardamine pattersonii*	OR	Plant	BS
Bitterweed, Richardson's	*Hymenoxys richardsonii*	ID	Plant	BS
Blackbird, Tricolored	*Agelaius tricolor*	CA, NV	Bird	BS
Bladderpod, Beautiful	*Lesquerella pulchella*	MT	Plant	BS
Bladderpod, Calder's	*Lesquerella calderi*	AK	Plant	BS
Bladderpod, Dudley Bluffs	*Lesquerella congesta*	CO	Plant	FT
Bladderpod, Fremont	*Lesquerella fremontii*	WY	Plant	BS
Bladderpod, Garnet	*Lesquerella carinata* var. *languida*	MT	Plant	BS
Bladderpod, Kodachrome	*Lesquerella rubicundula (=Lesquerella tumulosa)*	UT	Plant	FE
Bladderpod, Large-fruited	*Lesquerella macrocarpa*	WY	Plant	BS
Bladderpod, Montrose	*Lesquerella vicina*	CO	Plant	BS
Bladderpod, Pagosa	*Lesquerella pruinosa*	CO	Plant	BS
Bladderpod, Piceance	*Lesquerella parviflora*	CO	Plant	BS
Bladderpod, Prostrate	*Lesquerella prostrata*	WY	Plant	BS
Bladderpod, Pryor Mountains	*Lesquerella lesicii*	MT	Plant	BS
Bladderpod, Sidesaddle	*Lesquerella arenosa* var. *agrillosa*	WY	Plant	BS
Bladderpod, Western	*Lesquerella multiceps*	WY	Plant	BS
Bladderpod, Whitebluff's	*Lesquerella tuplashensis*	WA	Plant	C
Blazingstar, Ash Meadows	*Mentzelia leucophylla*	NV	Plant	FT
Blazingstar, Bractless	*Mentzelia nuda*	MT	Plant	BS
Blazingstar, Dwarf	*Mentzelia pumila*	MT, ND	Plant	BS
Blazingstar, Golden	*Mentzelia chrysantha*	CO	Plant	BS
Blazingstar, Goodrich's	*Mentzelia goodrichii*	UT	Plant	BS
Blazingstar, Many-stemmed	*Mentzelia multicaulis* var. *librina*	UT	Plant	BS
Blazingstar, Parckard's	*Mentzelia packardiae*	NV	Plant	BS
Blazingstar, Shultz'	*Mentzelia shultziorum*	UT	Plant	BS
Blazingstar, Soft	*Mentzelia montana*	MT	Plant	BS
Blazingstar, Tiehm	*Mentzelia tiehmii*	NV	Plant	BS
Bluebell, Drummond's	*Mertensia drummondii*	AK	Plant	BS
Blue-eyed grass, Hitchcok's	*Sisyrinchium hitchcockii*	OR	Plant	BS
Blue-eyed grass, Mountain	*Sisyrinchium sarmentosum*	WA	Plant	BS
Blue-eyed grass, Pale	*Sisyrinchium pallidum*	CO	Plant	BS
Bluegrass, Alaska	*Poa hartzii* ssp. *alaskana*	AK	Plant	BS
Bluegrass, Loose-flowered	*Poa laxiflora*	OR	Plant	BS
Bluegrass, Ocean-bluff	*Poa unilateralis*	OR	Plant	BS
Bluegrass, Short-leaved	*Poa arnowiae*	MT	Plant	BS
Blue-star, Fugate's	*Amsonia fugatei*	NM	Plant	BS
Blue-star, Jones	*Amsonia jonesii*	CO	Plant	BS

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Blue-star, Kearney's	*Amsonia kearneyana*	AZ	Plant	FE
Blue-star, Peebles	*Amsonia peeblesii*	AZ	Plant	BS
Blue-star, Tharps	*Amsonia tharpii*	NM	Plant	BS
Boa, Rosy	*Lichanura trivirgata*	AZ, CA	Reptile	BS
Bobolink	*Dolichonyx oryzivorus*	NV, OR	Bird	BS
Bog orchid, Alcove	*Platanthera zothecina*	UT	Plant	BS
Bog sedge, Simple	*Kobresia simpliciuscula*	MT	Plant	BS
Bog Thistle, Chorro Creek	*Cirsium fontinale* var. *obispoense*	CA	Plant	FE
Bolandra, Oregon	*Bolandra oregana*	OR	Plant	BS
Bolete, Red-pored	*Boletus haematinus*	OR	Fungi	BS
Boneset, Western	*Ageratina occidentalis*	MT	Plant	BS
Brant, Black	*Branta bernicla*	AK	Bird	BS
Breadroot, Indian Small	*Pediomelum pentaphyllum*	NM	Plant	BS
Breadroot, Intermountain	*Pediomelum megalanthum* var. *epipsilum*	UT	Plant	BS
Breadroot, Paradox	*Pediomelum aromaticum*	CO, UT	Plant	BS
Brittlebrush, Annual	*Psathyrotes annua*	ID	Plant	BS
Brodiaea, Orcutt's	*Brodiaea orcuttii*	CA	Plant	BS
Brodiaea, Thread-leaved	*Brodiaea filifolia*	CA	Plant	FT
Broom, Round-leaf	*Errazurizia rotundata*	AZ	Plant	BS
Buckwheat, Altered Andesite	*Eriogonum robustrum*	NV	Plant	BS
Buckwheat, Brandegee Wild	*Eriogonum brandegeei*	CO	Plant	BS
Buckwheat, Bull Mountain	*Eriogonum cronquisti*	UT	Plant	BS
Buckwheat, Cache Peak	*Eriogonum kennedyi* var. *pinicola*	CA	Plant	BS
Buckwheat, Calcareous	*Eriogonum ochrocephalum* var. *calcareum*	ID	Plant	BS
Buckwheat, Clay-loving Wild	*Eriogonum pelinophilum*	CO	Plant	FE
Buckwheat, Clokey	*Eriogonum heermannii* var. *clokeyii*	NV	Plant	BS
Buckwheat, Colorado Wild	*Eriogonum coloradense*	CO	Plant	BS
Buckwheat, Comb Wash	*Eriogonum clavellatum*	CO	Plant	BS
Buckwheat, Crosby's	*Eriogonum crosbyae*	CA, NV	Plant	BS
Buckwheat, Cushenbury	*Eriogonum ovalifolium* var. *vineum*	CA	Plant	FE
Buckwheat, Cusick's	*Eriogonum cusickii*	OR	Plant	BS
Buckwheat, Desert	*Eriogonum desertorum*	ID	Plant	BS
Buckwheat, Duchesne	*Eriogonum viridulum*	CO	Plant	BS
Buckwheat, Ephedra	*Eriogonum ephedroides*	CO	Plant	BS
Buckwheat, Flat-top	*Eriogonum smithii*	MT	Plant	BS
Buckwheat, Forked	*Eriogonum bifurcatum*	CA, NV	Plant	BS
Buckwheat, Frisco	*Eriogonum soredium*	CA	Plant	BS
Buckwheat, Grand	*Eriogonum contortum*	CO	Plant	BS
Buckwheat, Golden	*Eriogonum corymbosum* var. *aureum*	NV	Plant	BS
Buckwheat, Gypsum Wild	*Eriogonum gypsophilum*	NM	Plant	FT
Buckwheat, Heerman's Wild	*Eriogonum heermannii* var. *occidentale*	NV	Plant	BS
Buckwheat, Ione	*Eriogonum apricum* var. *apricum*	CA	Plant	FE
Buckwheat, Klamath Mountain	*Eriogonum hirtellum*	CA	Plant	BS
Buckwheat, Lewis	*Eriogonum lewisii*	NV	Plant	BS
Buckwheat, Matted	*Eriogonum caespitosum*	MT	Plant	BS
Buckwheat, Matted Cowpie (Shockley's Matted Buckwheat)	*Eriogonum shockleyi* var. *shockleyi*	ID	Plant	BS
Buckwheat, Mouse	*Eriogonum nudum* var. *murinum*	CA	Plant	BS
Buckwheat, Packard's Cowpie	*Eriogonum shockleyi* var. *packardiae*	ID	Plant	BS

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Buckwheat, Panamint Mtn.	*Eriogonum microthecum* var. *panamintense*	CA	Plant	BS
Buckwheat, Prostrate (Austin Buckwheat)	*Eriogonum prociduum*	CA, NV, OR	Plant	BS
Buckwheat, Railroad Canyon	*Eriogonum soliceps*	UT	Plant	BS
Buckwheat, Red Mountain	*Eriogonum kelloggii*	CA	Plant	C
Buckwheat, San Carlos Wild	*Eriogonum capillare*	NM	Plant	BS
Buckwheat, San Pedro	*Eriogonum terrenatum*	AZ	Plant	BS
Buckwheat, Scarlet	*Eriogonum phoeniceum*	NV	Plant	BS
Buckwheat, Smooth	*Stenogonum salsuginosum*	MT	Plant	BS
Buckwheat, Snow Mountain	*Eriogonum nervulosum*	CA	Plant	BS
Buckwheat, Steamboat	*Eriogonum ovalifolium* var. *williamsiae*	NV	Plant	FE
Buckwheat, Sulphurflower	*Eriogonum umbellatum* var. *glaberrimum*	CA, OR	Plant	BS
Buckwheat, Tiehm	*Eriogonum tiehmii*	NV	Plant	BS
Buckwheat, Tremblor	*Eriogonum temblorense*	CA	Plant	BS
Buckwheat, Umtanum Desert	*Eriogonum codium*	WA	Plant	C
Buckwheat, Vishor's	*Eriogonum visheri*	MT, ND, SD	Plant	BS
Buckwheat, Welsh's	*Eriogonum capistratum* var. *welshii*	ID	Plant	BS
Buckwheat, Wild Rose Canyon	*Eriogonum eremicola*	CA	Plant	BS
Buckwheat, Wild Single-stemmed	*Eriogonum acaule*	CO	Plant	BS
Buckwheat, Windloving	*Eriogonum anemophilum*	NV, UT	Plant	BS
Buckwheat, Woodside	*Eriogonun tumulosum*	CO	Plant	BS
Buckwheat, Yukon Wild	*Eriogonum flavum* var. *aquilinum*	AK	Plant	BS
Buckwheat, Zion	*Eriogonum zionis* var. *zionis*	UT	Plant	BS
Bug, Harney Hot Spring Shore	*Micracanthia fennica*	OR	Insect	BS
Bug, Pahranagat Naucorid	*Pelociris shoshone shoshone*	NV	Insect	BS
Bug, Santa Rita Mountains Chlorochroan	*Chlorochroa rita*	AZ	Insect	BS
Bugbane, Tall	*Actea elata*	OR, WA	Plant	BS
Bug moss, Green	*Buxbaumia viridis*	CA	Plant	BS
Bug-on-a-stick, Leafless	*Buxbaumia aphylla*	OR	Bryophyte	BS
Bug-on-a-stick, Piper's	*Buxbaumia piperi*	CA	Bryophyte	BS
Bullrush, Little (Rolland's)	*Trichophorum pumilum*	CO, ID, MT	Plant	BS
Bullrush, Slender	*Schoenoplectus heterochaetus*	MT	Plant	BS
Bunting, McKay's	*Plectrophenax hyperboreus*	AK	Bird	BS
Burbot	*Lota lota*	ID	Fish	BS
Bush lupine, Mountain Springs	*Lupinus excubitus* var. *medius*	CA	Plant	BS
Bush-mallow, Carmel Valley	*Malacothamnus palmeri*	CA	Plant	BS
Bush-mallow, Indian Valley	*Malacothamnus aboriginum*	CA	Plant	BS
Buttercup, Alaskan Glacier	*Ranunculus glacialis* var. *alaskana*	AK	Plant	BS
Buttercup, Alaskan Glacier	*Ranunculus glacialis* var. *chamissonis*	AK	Plant	BS
Buttercup, Autumn	*Ranunculus aestivalis*	UT	Plant	FE
Buttercup, Dalles Mountain	*Ranunculus triternatus*	WA	Plant	BS
Buttercup, Southern Oregon	*Ranunculus austrooreganus*	OR	Plant	BS
Butterfly Plant, Colorado	*Gaura neomexicana* ssp. *coloradensis*	CO, WY	Plant	FT
Butterfly, Baking Powder Flat Blue	*Euphilotes bernadino minuta*	NV	Insect	BS
Butterfly, Carson Valley Silverspot	*Speyeria nokomis carsonensis*	NV	Insect	BS
Butterfly, Desert Viceroy	*Limenitis archippus obsoleta*	NM	Insect	BS
Butterfly, Early Blue	*Euphilotes enoptes primavera*	NV	Insect	BS
Butterfly, Fender's Blue	*Icaricia icarioides fenderi*	OR	Insect	FE

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Butterfly, Fused Battoides Blue	*Euphilotes battoides fusimaculata*	NV	Insect	BS
Butterfly, Giulani's Blue	*Eupilotes ancilla giulanii*	NV	Insect	BS
Butterfly, Great Basin Small Blue	*Philotiella speciiosa septentrionalis*	NV	Insect	BS
Butterfly, Grey's Silverspot	*speyeria hesperis greyi*	NV	Insect	BS
Butterfly, Honey Lake Blue	*Euphilotes pallescens calneva*	NV	Insect	BS
Butterfly, Insular Blue	*Plebejus saepiolus insulanus*	OR	Insect	BS
Butterfly, Koret's Checkerspot	*Euphyrdryas editha koreti*	NV	Insect	BS
Butterfly, Mattoni's Blue	*Euphilotes pallescens mattonii*	NV	Insect	BS
Butterfly, Mono Checkerspot	*Euphyrdyas editha monoenisis*	NV	Insect	BS
Butterfly, New Mexico Silverspot	*Speyeria nokomis nitocris*	NM	Insect	BS
Butterfly, Northern Mojave Blue	*Euphilotes mojave virginensis*	NV	Insect	BS
Butterfly, Oregon Silverspot	*Speyeria zerene hippolyta*	OR	Insect	FT
Butterfly, Quino Checkerspot	*Euphydryas editha quino*	CA	Insect	FE
Butterfly, Rice's Blue	*Euphilotes pallescens ricei*	NV	Insect	BS
Butterfly, Sand Mountain Blue (also Small Blue Butterfly)	*Euphilotes pallescens* ssp. *arenamontana*	NV	Insect	BS
Butterfly, Shield's Blue	*Euphilotes ancilla shieldsi*	NV	Insect	BS
Butterfly, Steptoe Valley Crescentspot	*Phyciodes pascoiensis arenacolor*	NV	Insect	BS
Butterfly, Taylor's Checkerspot	*Euphydrayas editha taylori*	OR	Insect	C
Butterfly, Uncomopahgre Fritillary	*Boloria acrocnema*	CO	Insect	FE
Butterweed, Layne's	*Packera layneae (=Senecio layneae)*	CA	Plant	FT
Cabbage, Wild	*Caulanthus major* var. *nevadensis*	OR	Plant	BS
Cactus, Acuna	*Sclerocactus erectocentrus (=Echinomastus erectocentrus* var. *acunensi)*	AZ	Plant	C
Cactus, Bakersfield	*Opuntia basilaris var. treleasei (=Opuntia treleasei)*	CA	Plant	FE
Cactus, Cushion	*Coryphantha vivipara*	ID	Plant	BS
Cactus, Knowlton	*Pediocactus knowltonii*	CO, NM	Plant	FE
Cactus, Peebles Navajo	*Pediocactus peeblesianus* var. *peeblesianus*	AZ	Plant	FE
Cactus, Pima Pineapple	*Coryphantha scheeri* var. *robustispina*	AZ	Plant	FE
Cactus, San Rafael	*Pediocactus despainii*	UT	Plant	FE
Cactus, Winkler	*Pediocactus winkleri*	UT	Plant	FT
Caddisfly, Haddock's Rhyacophilan	*Rhyacophila haddocki*	OR	Insect	BS
Caddisfly, Scott's Apatanian	*Allomyia scotti*	OR	Insect	BS
Calicoflower, Bach's	*Downingia bacigalupii*	ID	Plant	BS
Calicoflower, Harlequin	*Downingia insignis*	ID	Plant	BS
Camas, Howell's	*Camassia howellii*	OR	Plant	BS
Camissonia, Small	*Camissonia parvula*	MT	Plant	BS
Candle, Miner's	*Cryptantha scoparia*	MT	Plant	BS
Candle, Owl Creek Miner's	*Cryptantha subcapitata*	WY	Plant	BS
Candytuft, Pear-shaped	*Smelowskia pyriformis*	AK	Plant	BS
Caribou, Woodland	*Rangifer tarandus caribou*	ID, MT, WA	Mammal	FE
Catchfly, Gentian	*Eustoma exaltatum*	NV	Plant	BS
Catchfly, Jan's (Nachlinger Catchfly)	*Silene nachlingerae*	NV	Plant	BS
Catchfly, Plank's	*Silene plankii*	NM	Plant	BS
Catchfly, Spalding's	*Silene spaldingii*	ID, MT, OR, WA	Plant	FT
Catchfly, Wright's	*Silene wrightii*	NM	Plant	BS

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Cat's-eye, Creutzfeldt's	*Cryptantha creutzfeldtii*	UT	Plant	BS
Cat's-eye, Fendler's	*Cryptantha fendleri*	MT	Plant	BS
Cat's-eye, Mariposa	*Cryptantha mariposae*	CA	Plant	BS
Cat's-eye, Shacklette's	*Cryptantha shackletteana*	AK	Plant	BS
Cat's-eye, Smooth	*Cryptantha semiglabra*	UT	Plant	BS
Catseye, White River (Welsh Catseye)	*Cryptantha welshii*	NV	Plant	BS
Cauliflower fungus	*Sparassis crispa*	CA	Fungi	BS
Caulostramina, Jaeger's	*Caulostramina jaegeri*	CA	Plant	BS
Ceanothus, Calistoga	*Ceanothus divergens*	CA	Plant	BS
Ceanothus, Lakeside	*Ceanothus cyaneus*	CA	Plant	BS
Ceanothus, Mahala-mat	*Ceanothus prostratus*	ID	Plant	BS
Ceanothus, Rincon Ridge	*Ceanothus confusus*	CA	Plant	BS
Centaury, Spring-loving	*Centaurium namophilum*	CA, NV	Plant	FT
Chaenactis, Shasta	*Chaenactis suffrutescens*	CA	Plant	BS
Chaffweed	*Anagallis minima*	MT	Plant	BS
Chanterelle, Blue	*Polyozellus multiplex*	CA	Fungi	BS
Char, Angayukaksurak	*Salvelinus anaktuvukensis*	AK	Fish	BS
Char, Kigliak	*Salvelinus alpinus*	AK	Fish	BS
Chat, Yellow-breasted	*Icteria virens*	CO, NV, OR	Bird	BS
Checkerbloom, Hickman's	*Sidalcea hickmanii* ssp. *nov*	OR	Plant	C
Checkerbloom, Parish's	*Sidalcea hickmanii* ssp. *parishii*	CA	Plant	C
Checker-mallow, Butte County	*Sidalcea robusta*	CA	Plant	BS
Checker-mallow, Coast	*Sidalcea oregano* ssp. *eximia*	CA	Plant	BS
Checker-mallow, Dwarf	*Sidalcea malviflora* ssp. *patula*	CA, OR	Plant	BS
Checker-mallow, Henderson's	*Sidalcea hendersonii*	OR	Plant	BS
Checker-mallow, Keck's	*Sidalcea keckii*	CA	Plant	FE
Checker-mallow, Meadow	*Sidalcea campestris*	OR	Plant	BS
Checker-mallow, Nelson's	*Sidalcea nelsoniana*	OR, WA	Plant	FT
Checker-mallow, Wenatchee Mountains	*Sidalcea oregana* var. *calva*	WA	Plant	FE
Checkerspot, Spring Mountain Acastus	*Chlosyne acastus robusta*	NV	Insect	BS
Chia, Clay	*Salvia columbariae* var. *argillacea*	UT	Plant	BS
Chipmunk, Cliff	*Tamias dorsalis*	ID	Mammal	BS
Chipmunk, Gray-footed	*Tamias canipes*	NM	Mammal	BS
Chipmunk, Organ Mountain Colorado	*Eutamias quadrivittatus australis*	NM	Mammal	BS
Chipmunk, Uinta	*Tamis umbrinus*	ID	Mammal	BS
Cholla, Munz	*Opuntia munzii*	CA	Plant	BS
Cholla, Santa Fe	*Opuntia xviridflora* (*imbricata x whipplei*)	NM	Plant	BS
Chub, Big Smoky Valley Tui	*Gila bicolor*	NV	Fish	BS
Chub, Bonytail	*Gila elegans*	AZ, CA, CO, NV, UT, WY	Fish	FE
Chub, Borax Lake	*Gila boraxobius*	OR	Fish	FE
Chub, Catlow Tui	*Gila bicolor*	OR	Fish	BS
Chub, Cowhead Lake Tui	*Gila bicolor vaccaceps*	CA	Fish	BS
Chub, Fish Creek Springs Tui	*Gila bicolor isolata*	NV	Fish	BS
Chub, Fish Lake Valley Tui	*Gila bicolor*	NV	Fish	BS
Chub, Flathead	*Hybopsis (Platygobio) gracilis*	CO, NM	Fish	BS

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Chub, Gila	*Gila intermedia*	AZ, NM	Fish	PE
Chub, Hot Creek Valley Tui	*Gila bicolor*	NV	Fish	BS
Chub, Humpback	*Gila cypha*	AZ, CO, UT, WY	Fish	FE
Chub, Hutton Tui	*Gila bicolor*	OR	Fish	FT
Chub, Independence Valley Tui	*Gila bicolor newarkensis*	NV	Fish	BS
Chub, Least	*Iotichthys phlegethontis*	NM	Fish	BS
Chub, Leatherside	*Gila copei*	ID, UT, WY	Fish	BS
Chub, Mohave Tui	*Gila bicolor mohavensis*	CA	Fish	FE
Chub, Newark Valley Tui	*Gila bicolor newarkensis*	NV	Fish	BS
Chub, Oregon	*Oregonichthys crameri*	OR	Fish	FE
Chub, Oregon Lakes Tui	*Gila bicolor oregonensis*	OR	Fish	BS
Chub, Owens Tui	*Gila bicolor snyderi*	CA	Fish	FE
Chub, Pahranagat Roundtail	*Gila robusta jordani*	NV	Fish	FE
Chub, Railroad Valley Tui	*Gila bicolor*	NV	Fish	BS
Chub, Rio Grande	*Gila pandora*	CO	Fish	BS
Chub, Roundtail	*Gila robusta*	CO, NM, UT, WY	Fish	BS
Chub, Sheldon Tui	*Gila bicolor eurysoma*	OR	Fish	BS
Chub, Sicklefin	*Macrhybopsis meeki*	MT	Fish	BS
Chub, Sturgeon	*Macrhybopsis gelida*	MT, UT	Fish	BS
Chub, Summer Basin Tui	*Gila bicolor*	OR	Fish	BS
Chub, Umpqua	*Oregonichthys kalawatsei*	OR	Fish	BS
Chub, Virgin River	*Gila seminude (=robusta)*	AZ, NV, UT	Fish	FE
Chuckwalla	*Sauromalus obesus*	AZ	Reptile	BS
Chuckwalla, Glen Canyon	*Sauromalus obesus multiforaminatus*	UT	Reptile	BS
Chuckwalla, Western	*Sauromalus obesus obesus*	UT	Reptile	BS
Cinquefoil, Common	*Potentilla cottamii*	NV, UT	Plant	BS
Cinquefoil, Platte	*Potentilla plattensis*	MT	Plant	BS
Cinquefoil, Soldier Meadow	*Potentilla basaltica*	CA, NV	Plant	C
Cinquefoil, Stipulated	*Potentilla stipularis*	AK	Plant	BS
Cisco, Bonneville	*Prosopium gemmiferum*	ID	Fish	BS
Clarkia, Beaked	*Clarkia rostrata*	CA	Plant	BS
Clarkia, Brandeegee's	*Clarkia biloba* ssp. *bandeegee*	CA	Plant	BS
Clarkia, Brewer's	*Clarkia breweri*	CA	Plant	BS
Clarkia, Caliente	*Clarkia tembloriensis* ssp. *calientensis*	CA	Plant	BS
Clarkia, Mariposa	*Clarkia biloba* ssp. *australis*	CA	Plant	BS
Clarkia, Mildred's	*Clarkia mildrediae* ssp. *mildrediae*	CA	Plant	BS
Clarkia, Mosquin's	*Clarkia mosquinii*	CA	Plant	BS
Clarkia, Northern	*Clarkia borealis* ssp. *borealis*	CA	Plant	BS
Clarkia, Shasta	*Clarkia borealis* ssp. *arida*	CA	Plant	BS
Clarkia, Small Southern	*Clarkia australis*	CA	Plant	BS
Clarkia, Springville	*Clarkia springvillensis*	CA	Plant	FT
Clarkia, White-stemmed	*Clarkia gracilis* ssp. *albicaulis*	CA	Plant	BS
Cleomella, Flat-seeded	*Cleomella plocasperma*	ID	Plant	BS
Cliff-rose, Arizona	*Purshia xsubintegra (pinkave* x *stansburiana) (=Purshia subintegra)*	AZ	Plant	FE
Clover, Barneby's	*Trifolium barnebyi*	WY	Plant	BS
Clover, DeDecker's	*Trifolium dedeckerae*	CA	Plant	BS
Clover, Douglas'	*Trifolium douglasii*	OR	Plant	BS
Clover, Frisco	*Trifolium friscanum*	UT	Plant	BS

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Clover, Leiberg's	*Trifolium leibergii*	NV, OR	Plant	BS
Clover, Mogollon	*Trifolium neurophyllum*	NM	Plant	BS
Clover, Mountain	*Trifolium andinum*	CO	Plant	BS
Clover, Mountain	*Trifolium andinum* var. *podocephalum*	NV	Plant	BS
Clover, Owyhee	*Trifolium owyheense*	ID	Plant	BS
Clover, Plumed	*Trifolium plumosum* var. *amplifolium*	ID	Plant	BS
Clover, Santa Cruz	*Trifolium buckwestorium*	CA	Plant	BS
Clover, Thompson's	*Trifolium thompsonii*	OR	Plant	BS
Clubrush, Water	*Schoenoplectus subterminalis*	ID	Plant	BS
Collomia, Barren Valley	*Collomia renacta*	NV, OR	Plant	BS
Collomia, Mount Mazama	*Collomia mazama*	ID	Plant	BS
Collybia, Branched	*Collybia racemosa*	CA	Fungi	BS
Columbine, Golden	*Aquilegia chrysantha* var. *rydbergii*	ID	Plant	BS
Columbine, Laramie	*Aquilegia laramiensis*	WY	Plant	BS
Columbine, Lori's	*Aquilegia loriae*	UT	Plant	BS
Columbine, Sitka	*Aquilegia formosa*	MT	Plant	BS
Combleaf, Desert	*Polyctenium fremontii confertum*	OR	Plant	BS
Combleaf, William's	*Polyctenium williamsiae*	CA, OR	Plant	BS
Condor, California	*Gymnogyps californianus*	AZ, CA, UT	Bird	FE, XN
Contra yerba	*Pediomelum hypogaeum scaposum*	NM	Plant	BS
Coral, Hairy-stemmed	*Clavulina castanopes lignicola*	CA	Fungi	BS
Coral, Strap-shaped	*Clavariadelphus ligula*	CA	Fungi	BS
Coral Mushroom	*Ramaria spinulosa*	OR	Fungi	BS
Coral Mushroom	*Ramaria spinulosa* var. *diminutiva*	OR	Fungi	BS
Coral Mushroom, Orange	*Ramaria largentii*	CA	Fungi	BS
Coral Mushroom, Pinkish	*Ramaria amyloidea*	CA	Fungi	BS
Coral Mushroom, Pinkish	*Ramaria cyaneigranosa*	CA	Fungi	BS
Coral Mushroom, Yellow	*Ramaria aurantiisiccescens*	CA	Fungi	BS
Coralroot, Arizona	*Hexalectris spicata* var. *arizonica*	NM	Plant	BS
Coralroot, Chisos Mountains	*Hexalectris revoluta*	AZ	Plant	BS
Coralroot, Glass Mountain	*Hexalectris nitida*	NM	Plant	BS
Coralroot, Purple-spike	*Hexalectris warnockii*	AZ	Plant	BS
Coreopsis, Mount Hamilton	*Coreopsis hamiltonii*	CA	Plant	BS
Cory cactus, Duncan's	*Escobaria dasyacantha* var. *duncanii*	NM	Plant	BS
Corydalis, Case's	*Corydalis caseana* var. *hastata*	ID	Plant	BS
Corydalis, Cold-water	*Corydalis caseana* ssp. *aquae-gelidae*	OR	Plant	BS
Cottongrass, Slender	*Eriophorum gracile*	CO	Plant	BS
Coyote-thistle, Oregon	*Eryngium petiolatum*	OR	Plant	BS
Crane, Whooping	*Grus americana*	CO, ID, MT, WY	Bird	FE, XN
Crazyweed, Challis	*Oxytropis besseyi* var. *salmonensis*	ID	Plant	BS
Crazyweed, Columbia	*Oxytropis campestris* var. *columbiana*	WA	Plant	BS
Crazyweed, Wanapum	*Oxytropis campestris* var. *wanapum*	WA	Plant	BS
Cream-scas, Pink	*Castilleja rubicundula* ssp. *rubicundula*	CA	Plant	BS
Cricket, Arizona Giant Sand Treader	*Daihinibaenetes arizonensis*	AZ	Insect	BS
Cricket, Mary's Peak Ice	*Grylloblatta* sp.	OR	Insect	BS
Cricket, Navajo Jerusalem	*Stenopelmatus navajo*	AZ	Insect	BS
Crownscale, San Jacinto Valley	*Atriplex coronata* var. *notatior*	CA	Plant	FE
Cryptantha, Gander's	*Cryptantha ganderi*	CA	Plant	BS
Cryptantha, Mound	*Cryptantha compacta*	UT	Plant	BS
Cryptantha, Osterhout	*Cryptantha osterhoutii*	CO	Plant	BS

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Cryptantha, Rollins	*Cryptantha rollinsii*	CO	Plant	BS
Cryptantha, Schoolcraft's (School Catseye)	*Cryptantha sobolifera*	CA, NV	Plant	BS
Cryptantha, Silky	*Cryptantha crinata*	CA	Plant	BS
Cryptantha, Tufted	*Cryptantha caespitosa*	CO, ID	Plant	BS
Cryptantha, Unita Basin	*Cryptantha breviflora*	ID	Plant	BS
Cuckoo, Western Yellow-billed	*Coccyzus americanus occidentalis*	AZ, CA, CO, ID, MT, NM, NV, OR, UT, WY	Bird	C
Cui-ui	*Chasmistes cujus*	NV	Fish	FE
Curlew, Bristle-thighed	*Numenius tahitiensis*	AK	Bird	BS
Curlew, Eskimo	*Numenius borealis*	AK	Bird	FE
Curlew, Long-billed	*Numenius americanus*	CO, MT, NV, UT, WY	Bird	BS
Currant, Moreno San Diego	*Ribes canthariforme*	CA	Plant	BS
Cutthroat, Bear Lake	*Oncorhynchus clarki utah*	ID	Fish	BS
Cycladenia, Jones	*Cycladenia humilis* var. *jonesii*	AZ, UT	Plant	FT
Cymopterus, Desert	*Cymopterus deserticola*	CA	Plant	BS
Cypress, Piute	*Cupressus arizonica* ssp. *nevadensis*	CA	Plant	BS
Cypress, Tecate	*Cupressus forbesii*	CA	Plant	BS
Dace, Ash Meadows Speckled	*Rhinichthys osculus nevadensis*	NV	Fish	FE
Dace, Big Smoky Valley Speckled	*Rhinichthys osculus lariversi*	NV	Fish	BS
Dace, Clover Valley Speckled	*Rhinichthys osculus oligiporus*	NV	Fish	FE
Dace, Desert	*Eremichthys acros*	NV	Fish	FT
Dace, Foskett Speckled	*Rhinichthys osculus* ssp.	OR	Fish	FT
Dace, Independence Valley Speckled	*Rhinichthys osculus lethoporus*	NV	Fish	FE
Dace, Kendall Warm Springs	*Rhinichthys osculus thermalis*	WY	Fish	FE
Dace, Longfin	*Agosia chrysogaster*	AZ, NM	Fish	BS
Dace, Meadow Valley Wash Speckled	*Rhinichthys osculus* spp.	NV	Fish	BS
Dace, Millicoma	*Rhinichthys cataractae*	OR	Fish	BS
Dace, Moapa	*Moapa coriacea*	NV	Fish	FE
Dace, Moapa Speckled	*Rhinichthys osculus moapae*	NV, OR	Fish	BS
Dace, Monitor Valley Speckled	*Rhinichthys osculus* spp.	NV	Fish	BS
Dace, Northern Redbelly X Finescale	*Phoxinus eos / X Phoxinus neogaeus*	MT	Fish	BS
Dace, Oasis Valley Speckled	*Rhinichthys osculus* spp.	NV	Fish	BS
Dace, Pahranagat Speckled	*Rhinichthys osculus velifer*	NV	Fish	BS
Dace, Pearl	*Margariscus margarita nachtriebi*	MT	Fish	BS
Dace, Relict	*Relictus solitarius*	NV	Fish	BS
Dace, Speckled	*Rhinichthys osculus*	AZ, NM	Fish	BS
Dace, White River Speckled	*Rhinichthys osculus* spp.	NV	Fish	BS
Daisy, Blochman's Leafy	*Erigeron blochmaniae*	CA	Plant	BS
Daisy, Hall's	*Erigeron aequifolius*	CA	Plant	BS
Daisy, Howell's	*Erigeron howellii*	OR	Plant	BS
Daisy, Kachina	*Erigeron kachinensis*	CO, UT	Plant	BS
Daisy, Kern River	*Erigeron multiceps*	CA	Plant	BS
Daisy, Maguire	*Erigeron maguirei*	UT	Plant	FT
Daisy, Oregon	*Erigeron oreganus*	OR	Plant	BS
Daisy, Panamint	*Enceliopsis covillei*	CA	Plant	BS
Daisy, Parish's	*Erigeron parishii*	CA	Plant	FT

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Daisy, Willamette	*Erigeron decumbens* var. *decumbens*	OR	Plant	FE
Dalea, Jones'	*Psorothamnus polydenius* var. *jonesii*	UT	Plant	BS
Dalea, Ornate	*Dalea ornata*	CA	Plant	BS
Dandelion, Rocky Mountain	*Taraxacum eriophorum*	MT	Plant	BS
Darter, Arkansas	*Etheostoma cragini*	CO	Fish	C
Darter, Iowa	*Etheostoma exile*	CO	Fish	BS
Darter, Orangethroat	*Etheostoma spectabile*	MT	Fish	BS
Deer, Columbian White-tailed	*Odocoileus virginianus leucurus*	OR (Douglas County)	Mammal	BS
Deer, Columbian White-tailed	*Odocoileus virginianus leucurus*	OR (Clatsop, Columbia, Multnomah counties)	Mammal	FE
Desertdandelion, Cliff	*Malacothrix saxatilis var. arachnoidea*	CA	Plant	BS
Desertdandelion, Torrey's	*Malacothrix torreyi*	MT	Plant	BS
Desertgrass, King's	*Blepharidachne kingii*	ID	Plant	BS
Desert-mallow, Rusby's	*Sphaeralcea rusbyi* var. *eremicola*	CA	Plant	BS
Desert-parsley, Adobe	*Lomatium roseanum*	CA, OR	Plant	BS
Desert-parsley, Bradshaw's	*Lomatium bradshawii*	OR, WA	Plant	FE
Desert-parsley, Colorado	*Lomatium concinnum*	CO	Plant	BS
Lomatium, Cook's	*Lomatium cookii*	OR	Plant	FE
Desert-parsley, Hoover's	*Lomatium tuberosum*	WA	Plant	BS
Desert-parsley, Nuttall's	*Lomatium nuttallii*	MT, SD	Plant	BS
Desert-parsley, Packard's	*Lomatium packardiae*	ID	Plant	BS
Desert-parsley, Rollins'	*Lomatium rollinsii*	WA	Plant	BS
Desert-parsley, Salmon-flower	*Lomatium salmoniflorum*	ID	Plant	BS
Desert-parsley, Taper-tip	*Lomatium attenuatum*	MT	Plant	BS
Dickcissel	*Spiza americana*	MT, UT	Bird	BS
Disc, Cockerell's Striate	*Discus shemeki cockerelli*	AZ, UT	Snail	BS
Disc, Marbled	*Discus marmorensis*	ID	Snail	BS
Dodder, Sepal-tooth	*Cuscuta denticulata*	ID	Plant	BS
Dogweed, Wright's	*Adenophyllum wrightii*	NM	Plant	BS
Donkey-ears	*Otidea onotica*	CA	Fungi	BS
Doublet (Dimeresia)	*Dimeresia howellii*	ID	Plant	BS
Dovekie	*Alle alle*	AK	Bird	BS
Draba, Bodie Hills	*Cusickiella quadricostata*	CA, NV	Plant	BS
Draba, Douglas'	*Cusickiella douglasii*	OR	Plant	BS
Draba, Globe-fruited	*Draba globosa*	ID, MT	Plant	BS
Draba, Mount Eddy	*Draba carnosula*	CA	Plant	BS
Draba, Small Petaled Alpine	*Draba alpina*	AK	Plant	BS
Draba, Wind River	*Draba ventosa*	MT	Plant	BS
Dropseed, Tall	*Sporobolus compositus* var. *comositus*	ID	Plant	BS
Duck, Canvasback	*Aythya valisineria*	MT	Bird	BS
Duck, Fulvous Whistling	*Dendrocygna bicolor*	AZ	Bird	BS
Duck, Harlequin	*Histrionicus histrionicus*	AK, ID, MT, WY	Bird	BS
Duck, Long-tailed	*Clangula hyemalis*	AK	Bird	BS
Dudleya, Many Stemmed	*Dudleya multicaulis*	CA	Plant	BS
Dudleya, San Luis Obispo Serpentine	*Dudleya abramsii* ssp. *bettinae*	CA	Plant	BS
Dudleya, Variegated	*Dudleya variegata*	CA	Plant	BS
Eagle, Bald	*Haliaeetus leucocephalus*	AK	Bird	BS

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Eagle, Bald	*Haliaeetus leucocephalus*	AZ, CA, CO, ID, MT, NM, NV, OR, UT	Bird	FT
Eagle, Golden	*Aquila chrysaetos*	NV, UT, WY	Bird	BS
Earthworm, Oregon Giant	*Driloleirus (Megascolides) macelfreshi*	OR	Annelid	BS
Easter-daisy, Cedar Mountain	*Townsendia microcephala*	WY	Plant	BS
Easter-daisy, Strigose	*Townsendia strigosa*	CO	Plant	BS
Eatonella, White	*Eatonella nivea*	ID, OR	Plant	BS
Eggvetch, Lavin	*Astragalus oophorus* var. *lavinii*	NV	Plant	BS
Eggvetch-long Calyx (Pink Eggvetch-long)	*Astragalus oophorus* var. *lonchocalyx*	NV, UT	Plant	BS
Eider, King	*Somateria spectabilis*	AK	Bird	BS
Eider, Spectacled	*Somateria fischeri*	AK	Bird	FT
Eider, Steller's	*Polystricta stelleri*	AK	Bird	FT
Elkweed, Pahute	*Frasera albicaulis* var. *modocensis*	NV	Plant	BS
Entoloma, Indigo	*Entoloma nitidum*	CA	Fungi	BS
Estes' artemisia	*Artemisia ludoviviana* ssp. *estesii*	OR	Plant	BS
Evening-primrose, Baird's	*Camissonia bairdii*	UT	Plant	BS
Evening-primrose, Cane Spring	*Camissonia megalantha*	NV	Plant	BS
Evening-primrose, Diamond Valley	*Camissonia gouldii*	UT	Plant	BS
Evening-primrose, Dwarf	*Camissonia pygmaea*	OR	Plant	BS
Evening-primrose, Hardham's	*Camissonia hardhamiae*	CA	Plant	BS
Evening-primrose, Murdock's	*Oenothera murdocki*	UT	Plant	BS
Evening-primrose, Narrowleaf	*Oenothera acutissima*	CO	Plant	BS
Evening-primrose, Obscure	*Camissonia andina*	MT	Plant	BS
Evening-primrose, Organ Mountain	*Oenothera organensis*	NM	Plant	BS
Evening-primrose, Palmer's	*Camissonia palmeri*	ID	Plant	BS
Evening-primrose, San Benito	*Camissonia benitensis*	CA	Plant	FT
Evening-primrose, Slender	*Camissonia exilis*	AZ	Plant	BS
Evening-primrose, St. Anthony	*Oenothera psammophila*	ID	Plant	BS
Evening-primrose, Winged-seed	*Camissonia pterosperma*	ID	Plant	BS
Evening-primrose, Wolf's	*Oenothera wolfii*	CA	Plant	BS
Fairy-fan	*Spathularia flavida*	CA	Fungi	BS
Fairy Shrimp, Conservancy	*Branchinecta conservatio*	CA	Crustacean	FE
Fairy Shrimp, Longhorn	*Branchinecta longiantenna*	CA	Crustacean	FE
Fairy Shrimp, Vernal Pool	*Branchinecta lynchi*	CA, OR	Crustacean	FT
Fairypoppy, White	*Meconella oregana*	OR	Plant	BS
Falcon, American Peregrine	*Falco peregrinus anatum*	AK, ID, MT, NM, NV, OR, UT, WY	Bird	BS
Falcon, Arctic Peregrine	*Falco peregrinus tundrius*	AK, NM, OR	Bird	BS
Falcon, Northern Aplomado	*Falco femoralis septentrionalis*	AZ, NM	Bird	FE
Falcon, Prairie	*Falco mexicanus*	ID, NV	Bird	BS
False Goldeneye, Tropical	*Heliomeris soliceps*	CA	Plant	BS
False Truffle, Yellow	*Leucogaster citrinus*	CA	Fungi	BS
Fawn-lily, Howell's	*Erythronium howellii*	OR	Plant	BS
Fawn-lily, Scott Mountain	*Erythronium citrinum* var. *roderickii*	CA	Plant	BS
Fawn-lily, Tuolumne	*Erythronium tuolumnense*	CA	Plant	BS
Feathergrass, Porter	*Ptilagrostis porteri*	CO	Plant	BS
Felwort, Marsh	*Lomatogonium rotatum*	ID, MT	Plant	BS
Fen Mustard, Penland Alpine	*Eutrema penlandii*	CO	Plant	FT

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Fern, Deer	*Blechnum spicant*	ID, NM	Plant	BS
Fern, Goldenback	*Pentagramma triangularis* ssp. *triangularis*	ID	Plant	BS
Ferret, Black-footed	*Mustela nigripes*	AZ, CO, MT, NM, UT, WY	Mammal	FE, XN
Feverfew, Ligulate	*Parthenium ligulatum*	CO	Plant	BS
Fiddleleaf, Matted	*Nama densum* var. *parviflorum*	CO	Plant	BS
Fiddleneck, Bent-flowered	*Amsinkia lunaris*	CA	Plant	BS
Fieldslug, Evening	*Deroceras hesperium*	OR	Snail	BS
Figwort, Organ Mountain	*Scrophularia laevis*	NM	Plant	BS
Finch, Black Rosy	*Leucosticte atrata*	NV	Bird	BS
Fireweed, Oregon	*Epilobium oreganum*	CA, OR	Plant	BS
Fisher	*Martes pennanti*	ID, OR	Mammal	BS
Fisher, Pacific	*Martes pennanti pacifica*	CA, OR	Mammal	BS
Fishhook Cactus, Blaine's	*Sclerocactus blainei*	NV	Plant	BS
Fishhook Cactus, Gramagrass	*Sclerocactus papyracanthus*	NM	Plant	BS
Cactus, Mesa Verde	*Sclerocactus mesae-verdae*	CO, NM	Plant	FT
Fishhook cactus, New Mexico	*Sclerocactus cloveriae* ssp. *brackii*	NM	Plant	BS
Fishhook cactus, Paria Plateau	*Sclerocactus sileri*	UT	Plant	BS
Fishhook Cactus, Short-spined	*Sclerocactus brevispinus*	UT	Plant	BS
Fishhook Cactus, Wright	*Sclerocactus wrightiae*	UT	Plant	FE
Flameflower, Cedar Mountain	*Talinum thompsonii*	UT	Plant	BS
Flameflower, Pinos Altos	*Talinum humile*	NM	Plant	BS
Flannelbush, California	*Fremontodendron californicum*	AZ, CA	Plant	BS
Flannelbush, Mexican	*Fremontodendron mexicanum*	CA	Plant	FE
Ceanothus, Pine Hill	*Ceanothus roderickii*	CA	Plant	FE
Flannelbush, Pine Hill	*Fremontodendron decumbens (=F. californicum ssp. decumbens)*	CA	Plant	FE
Flannelbush, Pine Hill	*Fremontodendron decumbens (=F. californicum ssp. sierra)*	CA	Plant	FE
Flatsedge, Schweinitz'	*Cyperus schweinitzii*	MT	Plant	BS
Flatworm	*Kenkia rhynchida*	OR	Annelid	BS
Flax, Brewer's Dwarf	*Hesperolinon breweri*	CA	Plant	BS
Flax, Drymaria-like Western	*Hesperolinon drymarioides*	CA	Plant	BS
Flax, Glandular Western	*Hesperolinon adenophyllum*	CA	Plant	BS
Flax, Napa Western	*Hesperolinon serpentinum*	CA	Plant	BS
Flax, Tehama County Western	*Hesperolinon tehamense*	CA	Plant	BS
Fleabane, Acoma	*Erigeron acomanus*	NM	Plant	BS
Fleabane, Basalt	*Erigeron basalticus*	OR	Plant	C
Fleabane, Bisti	*Erigeron bistiensis*	NM	Plant	BS
Fleabane, Broad	*Erigeron latus*	NV	Plant	BS
Fleabane, Buff	*Erigeron ochroleucus* var. *ochroleucus*	MT	Plant	BS
Fleabane, Desert Yellow	*Erigeron linearis*	MT	Plant	BS
Fleabane, Fish Creek	*Erigeron piscaticus*	AZ	Plant	BS
Fleabane, Idaho	*Erigeron asperugineus*	MT	Plant	BS
Fleabane, Indian Valley	*Erigeron untermannii*	UT	Plant	BS
Fleabane, Lemmon	*Erigeron lemmonii*	AZ	Plant	C
Fleabane, Muir's	*Erigeron muirii*	AK	Plant	BS
Fleabane, Sheep	*Erigeron ovinus*	NV	Plant	BS
Fleabane, Sivinski's	*Erigeron sivinskii*	NM	Plant	BS
Fleabane, Zuni	*Erigeron rhizomatus*	AZ, NM	Plant	FT

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Floater, California	*Anodonta californiensis*	ID, NV	Mollusk	BS
Flycatcher, Gray	*Empidonax wrightii*	CA	Bird	BS
Flycatcher, Hammond's	*Empidonax hammondii*	ID	Bird	BS
Flycatcher, Olive-sided	*Contopus borealis*	AK, ID, NM, OR, WY	Bird	BS
Flycatcher, Southwestern Willow	*Empidonax traillii extimus*	AZ, CA, CO, NM, NV, UT	Bird	FE
Flycatcher, Willow	*Empidonax traillii*	ID	Bird	BS
Fog-lichen, Powdery	*Vermilacina cephalota*	CA	Plant	BS
Four-o'clock, McFarlane's	*Mirabilis macfarlanei*	ID, OR	Plant	FT
Four-tooth Moss, Bent-kneed	*Tetraphis geniculata*	CA	Plant	BS
Fox, Kit	*Vulpes velox macrotis*	CA, ID	Mammal	BS
Fox, San Joaquin Kit	*Vulpes macrotis mutica*	CA	Mammal	FE
Fox, Swift	*Vulpes velox*	MT, WY	Mammal	BS
Fragrant Kalmiopsis	*Kalmiopsis fragrans*	OR (Douglas County)	Plant	BS
Fritillary, Gentner's	*Fritillaria gentneri*	CA, OR	Plant	FE
Fritillary, Ojai	*Fritillaria ojaiensis*	CA	Plant	BS
Fritillary, Nokomis	*Speyeria nokomis nokomis*	CO, UT	Insect	BS
Fritillary, San Benito	*Fritillaria viridea*	CA	Plant	BS
Fritillary, Talus	*Fritillaria falcata*	CA	Plant	BS
Frog, California Red-legged	*Rana aurora draytonii*	CA	Amphibian	FT
Frog, Chiricahua Leopard	*Rana chiricahuensis*	AZ, NM	Amphibian	FT
Frog, Columbia Spotted	*Rana luteiventris*	MT, OR, UT, WY	Amphibian	C
Frog, Columbia Spotted (Great Basin Population)	*Rana luteiventris*	ID, NV, OR	Amphibian	C
Frog, Foothill Yellow-legged	*Rana boyleii*	CA	Amphibian	BS
Frog, Northern Cricket	*Acris crepitans*	CA, NM, UT	Amphibian	BS
Frog, Northern Leopard	*Rana pipiens*	CO, ID, OR, WY	Amphibian	BS
Frog, Oregon Spotted	*Rana pretiosa*	OR, WY	Amphibian	C
Frog, Plain's Leopard	*Rana blairi*	CO	Amphibian	BS
Frog, Relict Leopard	*Rana onca*	NV	Amphibian	C
Frog, San Sebastian Leopard	*Rana yavapaiensis*	CA, NM, UT	Amphibian	BS
Frog, Stubble	*Calicium viride*	CA	Plant	
Frog, Tailed	*Ascaphus truei*	MT	Amphibian	BS
Frog, Wood	*Rana sylvatica*	MT	Amphibian	BS
Fuzzwort, Pacific	*Ptilidium californicum*	MT	Plant	BS
Gambusia, Pecos	*Gambusia nobilis*	NM	Fish	FE
Gar, Shortnose	*Lepisosteus platostomus*	MT	Fish	BS
Gecko, Utah Banded	*Coleonyx variegates utahensis*	UT	Reptile	BS
Gentian, Bristly	*Gentiana plurisetosa*	OR	Plant	BS
Gentian, Mendocino	*Gentiana setigera*	OR	Plant	BS
Gentian, Tufted Green	*Frasera paniculata*	CO	Plant	BS
Gentian, Utah	*Gentianella tortuosa*	CO	Plant	BS
Gila Monster	*Heloderma suspectum*	CA, UT	Reptile	BS
Gila Monster, Banded	*Heloderma suspectum cinctum*	AZ, NV, UT	Reptile	BS
Gilia, Aztec	*Gilia formosa*	NM	Plant	BS
Gilia, Ballhead	*Ipomopsis congesta* ssp. *crebriolia*	MT	Plant	BS
Gilia, Dark-eyed; Seaside	*Gilia millefoliata*	CA, OR	Plant	BS

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Gilia, Hollyleaf	*Gilia latifolia* var. *imperialis*	UT	Plant	BS
Gilia, Little San Bernardino Mountain	*Gilia maculata*	CA	Plant	BS
Gilia, Monterey	*Gilia tenuiflora* ssp. *arenaria*	CA	Plant	FE
Gilia, Mussentuchit	*Gilia tenuis*	UT	Plant	BS
Gilia, Narrowstem	*Gilia stenothyrsa*	CO	Plant	BS
Gilia, Pagosa Trumpet	*Ipomopsis polyantha*	CO	Plant	BS
Gilia, Rabbit Valley (Wonderland Gilia)	*Gilia caespitosa*	UT	Plant	BS
Gilia, Spreading	*Ipomopsis polycladon*	ID	Plant	BS
Gilia, Weber's Scarlet	*Ipomopsis aggregate* ssp. *weberi*	WY	Plant	BS
Glasswort, Red	*Salicornia rubra*	ID	Plant	BS
Globeberry, Texas	*Ibervillea tenuisecta*	AZ	Plant	BS
Globeberry, Tumamoc	*Tumamoca macdougalii*	AZ	Plant	BS
Globemallow, Baker's	*Iliamna bakeri*	CA, OR	Plant	BS
Globemallow, Gooseberry-leaf	*Sphaeralcea grossulariifolia* ssp. *grossulariifolia*	UT	Plant	BS
Globemallow, Jane's	*Sphaeralcea janeae*	UT	Plant	BS
Globemallow, Porter's	*Sphaeralcea procera*	NM	Plant	BS
Globemallow, Psoralia	*Sphaeralcea psoraloides*	UT	Plant	BS
Globemallow, Railroad Valley	*Sphaeralcea caespitosa* var. *caespitosa*	UT	Plant	BS
Globemallow, Railroad Valley	*Sphaeralcea caespitosa* var. *williamsiae*	NV	Plant	BS
Globemallow, White-stemmed	*Sphaeralcea munroana*	MT	Plant	BS
Glossopetalon, Pungent	*Glossopetalon pungens*	CA, NV	Plant	BS
Gnatcatcher, Coastal California	*Polioptila californica californica*	CA	Bird	FT
Goat's foot, Greening	*Albatrellus ellisii*	CA	Plant	BS
Godwit, Black-tailed	*Limosa limosa*	AK	Bird	BS
Godwit, Marbled	*Limosa fedoa*	AK	Bird	BS
Golden-aster, Huachuca	*Heterotheca rutteri*	AZ	Plant	BS
Golden-aster, Shevock's Hairy	*Heterotheca shevockii*	CA	Plant	BS
Goldenbush, Eastwood's	*Ericameria fasciculata*	CA	Plant	BS
Goldenbush, Greenwood's	*Ericameria lignumviridis*	UT	Plant	BS
Goldenbush, Pine Valley	*Ericameria crispa*	UT	Plant	BS
Goldenbush, Zion	*Ericameria zionis*	UT	Plant	BS
Golden-clover, Butte County	*Trifolium jokerstii*	CA	Plant	BS
Goldeneye, Barrow's	*Bucephala islandica*	CO, ID	Bird	BS
Goldeneye, Showy	*Heliomeris multiflora* var. *multiflora*	MT	Plant	BS
Goldenrod, Few-flowered	*Solidego velutina*	MT, SD	Plant	BS
Goldenstar, San Diego	*Muilla clevelandii*	CA	Plant	BS
Goldenweed, Bugleg	*Pyrrocoma insecticruris*	ID	Plant	BS
Goldenweed, Howell's One-flowered	*Pyrrocoma uniflora* var. *uniflora*	ID	Plant	BS
Goldenweed, Large-flowered	*Pyrrocoma carthamoides* var. *subsquarrosa*	MT	Plant	BS
Goldenweed, Palouse	*Pyrrocoma liatriformis*	ID, OR	Plant	BS
Goldenweed, Snake River	*Pyrrocoma radiata*	ID	Plant	BS
Goldfields, Contra Costa	*Lasthenia conjugens*	CA	Plant	FE
Goldfields, Coulter's	*Lasthenia glabrata* ssp. *coulteri*	CA	Plant	BS
Goldfields, Large-flowered	*Lasthenia macrantha* ssp. *prisca*	OR	Plant	BS
Goldthread, Three-leaf	*Coptis trifolia*	OR	Plant	BS
Goose, Aleutian Canada	*Branta canadensis leucopareia*	AK, CA, OR	Bird	DM
Goose, Dusky Canada	*Branta canadensis occidentalis*	AK	Bird	BS

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Goose, Tule White-fronted	*Anser albifrons gambelli*	AK	Bird	BS
Gooseberry, Sequoia	*Ribes tularense*	CA	Plant	BS
Goosefoot, Sandhill	*Chenopodium cycloides*	NM	Plant	BS
Gopher, Desert Pocket	*Geomys bursarius tularosae*	NM	Mammal	BS
Gopher, Fish Spring Pocket	*Thomomys bottae abstrusus*	NV	Mammal	BS
Gopher, Guadalupe Pocket	*Thomomys bottae guadalupensis*	NM	Mammal	BS
Gopher, Idaho Pocket	*Thomomys idahoensis*	WY	Mammal	BS
Gopher, San Antonio Pocket	*Thomomys bottae curtatus*	NV	Mammal	BS
Gopher, Southern Pocket	*Thomomys umbrinus emotus*	NM	Mammal	BS
Gopher, Wyoming Pocket	*Thomomys clusius*	WY	Mammal	BS
Goshawk, Northern	*Accipiter gentilis*	CO, ID, MT, NM, NV, OR, UT, WY	Bird	BS
Goshawk, Northern (Queen Charlotte)	*Accipiter gentilis laingi*	AK	Bird	BS
Gramma, Blue	*Bouteloua gracilis*	ID	Plant	BS
Grass Bug, American Acetropis	*Acetropis americana*	OR	Insect	BS
Grass, California Orcutt	*Orcuttia californica*	CA	Plant	FE
Grass, Hairy Orcutt	*Orcuttia pilosa*	CA	Plant	FE
Grass, San Joaquin Valley Orcutt	*Orcuttia inaequalis*	CA	Plant	FT
Grass, Semaphore	*Pleuropogon sabinei*	AK	Plant	BS
Grass, Sessile-leaved Scurvy	*Cochlearia sessilifolia*	AK	Plant	BS
Grass, Slender Orcutt	*Orcuttia tenuis*	CA	Plant	FT
Grasshopper, Idaho Pointheaded	*Acrolophitus punchellus*	ID	Insect	BS
Grayling, Arctic	*Thymallus arcticus*	MT	Fish	C
Grebe, Red-necked	*Podiceps grisegena*	OR	Bird	BS
Green-molly	*Kochia americana*	MT	Plant	BS
Greenbriar, English Peak	*Smilax jamesii*	CA	Plant	BS
Greenthread, Green River	*Thelesperma caespitosum*	UT, WY	Plant	BS
Greenthread, Uinta	*Thelesperma pubescens*	UT, WY	Plant	BS
Grosbeak, Blue	*Guiraca caerulea*	UT	Bird	BS
Grounddaisy, Charleston	*Townsendia jonesii* var. *tumulosa*	NV	Plant	BS
Groundsel, Spellenberg's	*Packera spellenbergii*	NM	Plant	BS
Grouse, Columbian Sharp-tailed	*Tympanuchus phasianellus columbianus*	CA, CO, ID, MT, NV, UT, WY	Bird	BS
Grouse, Sharp-tailed	*Tympanuchus phasianellus*	UT	Bird	BS
Guillemot, Black	*Cepphus grylle*	AK	Bird	BS
Gumplant, Ash Meadows	*Grindelia fraxino-pratensis*	CA, NV	Plant	FT
Gumweed, Howell's	*Grindelia howellii*	ID	Plant	BS
Gymnopilus, Blue-green	*Gymnopilus punctifolius*	CA	Plant	BS
Harebell, Castle Crags	*Campanula shetleri*	CA	Plant	BS
Harebell, Sharsmith's	*Campanula sharsmithiae*	CA	Plant	BS
Harmonia, Hall's	*Harmonia hallii*	CA	Plant	BS
Harmonia, Nile's	*Harmonia doris-nilesiae*	CA	Plant	BS
Harmonia, Stebbin's	*Harmonia stebbininsii*	CA	Plant	BS
Harrier, Northern	*Circus cyaneus*	ID	Bird	BS
Hawk, Ferruginous	*Buteo regalis*	CO, ID, MT, NM, NV, OR, UT, WY	Bird	BS
Hawk, Northern Gray	*Buteo nitidus maximus*	AZ, ID, MT,	Bird	BS

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		NM, WY		
Hawk, Swainson's	*Buteo swainsoni*	ID, MT, NV, UT	Bird	BS
Hawksbeard, Idaho	*Crepis bakeri* ssp. *idahoensis*	ID	Plant	BS
Hazardia, Orcutt's	*Hazardia orcuttii*	CA	Plant	BS
Hedgehog, Violet	*Sacodon fuscoindicus*	CA	Fungi	BS
Hedgehog cactus, Arizona	*Echinocereus coccineus* var. *arizonicus* (=*Echinocereus triglochidiatus* var. *arizonicus)*	AZ	Plant	FE
Hedgehog cactus, Fickeisen's	*Pediocactus peeblesianus* var. *fickeiseni*	AZ	Plant	C
Hedgehog cactus, Howe's	*Echinocereus engelmannii* var. *howei*	CA	Plant	BS
Hedgehog cactus, Kuenzler	*Echinocereus fendleri* var. *kuenzleri*	NM	Plant	FE
Hedgehog cactus, Simpson's	*Pediocactus simpsonii* var. *robustior*	ID	Plant	BS
Hesperian (Snail), Sister's	*Hochbergellus hirsutus*	OR	Snail	BS
Hesperian, Bald	*Vespericola* sp.	OR	Snail	BS
Hookless Cactus, Uinta Basin	*Sclerocactus glaucus*	CO, UT	Plant	FT
Hopsage, Spiny	*Grayia spinosa*	MT	Plant	BS
Horkelia, Henderson's	*Horkelia hendersonii*	CA	Plant	BS
Horkelia, Parry's	*Horkelia parryi*	CA	Plant	BS
Horkelia, Shaggy	*Horkelia congesta* ssp. *congesta*	OR	Plant	BS
Horse-mint, Cusick's	*Agastache cusickii*	MT	Plant	BS
Thelypody, Howell's Spectacular	*Thelypodium howellii spectabilis*	OR	Plant	FT
Howell's Spineflower	*Chorizanthe howellii*	CA	Plant	FE
Howellia, Water	*Howellia aquatilis*	CA, ID, MT, OR	Plant	FT
Hutchinsia, Prostrate	*Hutchinsia procumbens*	MT	Plant	BS
Hummingbird, Calliope	*Stellula calliope*	ID	Bird	BS
Ibis, White-faced	*Plegadis chihi*	AZ, CO, ID, NM, WY	Bird	BS
Iguana, Desert	*Dipsosaurus dorsalis*	UT	Reptile	BS
Indian-mallow, Pima	*Abutulon parishii*	AZ	Plant	BS
Indian Potato, Taper-root	*Orogenia fusiformis*	MT	Plant	BS
Indigo Bush, Gentry	*Dalea tentaculoides*	AZ	Plant	BS
Iris, Munz'	*Iris munzii*	CA	Plant	BS
Iris, Rocky Mountain	*Iris missouriensis*	UT	Plant	BS
Isopod, Socorro	*Thermosphaeroma thermophilus*	NM	Crustacean	FE
Ivesia, Alkali	*Ivesia kingii*	CA	Plant	BS
Ivesia, Ash Creek	*Ivesia paniculata*	CA	Plant	BS
Ivesia, Ash Meadows	*Ivesia kingii (=Ivesia kingii* var. *eremica)*	CA, NV	Plant	FT
Ivesia, Castle Crags	*Ivesia longibracteata*	CA	Plant	BS
Ivesia, Grimy	*Ivesia rhypara* var. *rhypara*	CA, NV	Plant	BS
Ivesia, Jaeger's	*Ivesia jaegeri*	CA, NV	Plant	BS
Ivesia, Kingston Mountains	*Ivesia patellifera*	CA	Plant	BS
Ivesia, Pickering's	*Ivesia pickeringii*	CA	Plant	BS
Ivesia, Pine Nut Mountains	*Ivesia pityocharis*	NV	Plant	BS
Ivesia, Plumas	*Ivesia sericoleuca*	CA	Plant	BS
Ivesia, Shelly's	*Ivesia rhypara* var. *shellyi*	OR	Plant	BS
Ivesia, Sierra Valley	*Ivesia aperta* var. *aperta*	CA, NV	Plant	BS
Ivesia, Webber's	*Ivesia webberi*	CA, NV	Plant	BS
Jaguar	*Panthera onca*	AZ, NM	Mammal	FE

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Jay, Pinyon	*Gymnorhinus cyanocephalus*	ID, NV	Bird	BS
Jewelflower, California	*Stanfordia california (=Caulanthus californicus)*	CA	Plant	FE
Jewelflower, Dorr's Cabin	*Streptanthus morrisonii* ssp. *hirtiflorus*	CA	Plant	BS
Jewelflower, Freed's	*Streptanthus brachiatus* ssp. *hoffmanii*	CA	Plant	BS
Jewelflower, Hoffmann's	*Streptanthus glandulosus* ssp. *secundus* var. *hoffmanii*	CA	Plant	BS
Jewelflower, Kruckeberg's	*Streptanthus morrisonii* ssp. *kruckebergi*	CA	Plant	BS
Jewelflower, Lemmon's	*Caulanthus coulteri*	CA	Plant	BS
Jewelflower, Masonic Mountain	*Streptanthus oliganthus*	CA, NV	Plant	BS
Jewelflower, Metcalf Canyon	*Streptanthus albidus* ssp. *albidus*	CA	Plant	FE
Jewelflower, Morrison's	*Streptanthus morrisonii* ssp. *morrisonii*	CA	Plant	BS
Jewelflower, Mount Hamilton	*Streptanthus callistus*	CA	Plant	BS
Jewelflower, Piute Mountains	*Streptanthus cordatus* var. *piutensis*	CA	Plant	BS
Jewelflower, Socrates Mine	*Streptanthus brachiatus* ssp. *brachiatus*	CA	Plant	BS
Jewelflower, Three Peaks	*Streptanthus morrisonii* ssp. *elatus*	CA	Plant	BS
Juga (Snail), Barren	*Juga hemphilli hemphilli*	OR	Snail	BS
Juga (Snail), Bulb	*Juga bulbosa*	OR	Snail	BS
Juga (Snail), Dalles	*Juga hemphilli dallesensis*	OR	Snail	BS
Juga (Snail), Opal Springs	*Juga* sp.	OR	Snail	BS
Juga, Purple-lipped (Deschutes Juga)	*Juga hemphilli maupinensis*	OR	Snail	BS
Jumping-slug, Malone	*Hemphillia malone*	OR	Snail	BS
Kentrophyta, Bastard	*Astragalus tegetarioides*	OR	Plant	BS
Kingsnake, California Mountain	*Lampropeltis zonata*	CA	Reptile	BS
Kingsnake, Common	*Lampropeltis getula*	CO	Reptile	BS
Kingsnake, Sonoran Mountain	*Lampropelitis pyromelana*	NV	Reptile	BS
Kingsnake, St. Helena Mountain	*Lampropeltis zonata zonata*	CA	Reptile	BS
Kingsnake, Utah Mountain	*Lampropeltis pyromelana infralabialis*	UT	Reptile	BS
Knot, Red	*Calidris canutus*	AK	Bird	BS
Knotweed, Modoc County	*Polygonum polygaloides* ssp. *esotericum*	CA	Plant	BS
Lacewing, Cheese-weed Moth	*Oliarces clara*	AZ	Insect	BS
Ladies'-tresses, Canelo Hills	*Spiranthes delitescens*	AZ	Plant	FE
Ladies'-tresses, Ute	*Spiranthes diluvialis*	CO, ID, MT, NE, UT, WA, WY	Plant	FT
Ladies'-tresses, Western	*Spiranthes porrifolia*	ID	Plant	BS
Lady's-slipper, Clustered	*Cypripedium fasciculatum*	CA, OR	Plant	BS
Lady's-slipper, Mountain	*Cypripedium montanum*	CA	Plant	BS
Lady's-slipper, Small Yellow	*Cypripedium parviflorum*	MT, ND	Plant	BS
Lady's-slipper, Yellow	*Cypripedium alpinum*	WA	Plant	BS
Lamprey, Goose Lake	*Lampetra tridentata* ssp.	CA, OR	Fish	BS
Lamprey, Pacific	*Lampetra tridentata*	ID	Fish	BS
Lamprey, Western Brook	*Lampetra richardsoni*	AK	Fish	BS
Lanx, Rotund	*Lanx subrotundata*	OR	Snail	BS
Lanx, Scale	*Lanx klamathensis*	OR	Snail	BS
Lanx, Shortface	*Fisherola nuttalli*	ID	Snail	BS
Laphamia, Inyo	*Perityle inyoensis*	CO	Plant	BS
Lark, Streaked Horned	*Eremophila alpestris strigata*	OR	Bird	C
Larkspur, Dune	*Delphinium parryi* ssp. *blochamaniae*	CA	Plant	BS
Larkspur, Kern County	*Delphinium purpusii*	CA	Plant	BS
Larkspur, Recurved	*Delphinium recurvatum*	CA	Plant	BS

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Larkspur, Umbrella	*Delphinium umbraculorum*	CA	Plant	BS
Larkspur, Wenatchee	*Delphinium viridescens*	OR	Plant	BS
Larkspur, White Rock	*Delphinium nuttallii* ssp. *ochroleucum*	WA	Plant	BS
Larkspur, Willamette Valley	*Delphinium nuttallii* ssp. *nuttallii*	OR	Plant	BS
Layia, Beach	*Layia carnosa*	CA	Plant	FE
Layia, Colusa	*Layia septentrionalis*	CA	Plant	BS
Layia, Jones's	*Layia jonesii*	CA	Plant	BS
Layia, Pale-yellow	*Layia heterotricha*	CA	Plant	BS
Leadplant	*Amorpha canescens*	MT	Plant	BS
Lemming, Northern Bog	*Synaptomys borealis*	ID, MT	Mammal	BS
Lettuce Lung	*Lobaria oregana*	CA	Plant	BS
Lewisia, Cantelow's	*Lewisia cantelovii*	CA	Plant	BS
Lewisia, Heckner's	*Lewisia cotyledon heckneri*	CA	Plant	BS
Lewisia, Purdy's	*Lewisia cotyledon* var. *cotyledon*	OR	Plant	BS
Lichen, Cat Paw	*Nephroma bellum*	CA	Plant	BS
Lichen, Dot	*Physcia semipinnata*	ID, OR	Plant	BS
Lichen, Dusty Cartilige	*Ramalina pollinaria*	CA	Plant	BS
Lichen, Earth	*Catapyrenium congestum*	ID	Plant	BS
Lichen, Horse-hair	*Bryoria pseudocapillaris*	CA	Plant	BS
Lichen, Horse-hair	*Bryoria spiralifera*	CA	Plant	BS
Lichen, Idaho Range	*Xanthoparmelia idahoensis*	ID	Plant	BS
Lichen, Long-beard	*Usnea longissima*	CA	Plant	BS
Lichen, Matted	*Pannaria rubiginosa*	CA	Plant	BS
Lichen, Nail	*Pilophorus acicularis*	ID	Plant	BS
Lichen, Orange Bush	*Teloschistes flavicans*	CA	Plant	BS
Lichen, Shield	*Heterodermia leucomelos*	CA	Plant	BS
Lichen, Short-spored Jelly	*Collema curtisporum*	ID	Plant	BS
Lichen, Skin	*Dermatocarpon lorenzianum*	ID	Plant	BS
Lichen, Worm	*Thamnolia vermicularis*	ID	Plant	BS
Lichen, Wovenspore	*Texosporium sancti-jacobi*	ID, OR	Plant	BS
Lichen, Yellow-twist Horse-hair	*Bryoria tortuosa*	CA	Plant	BS
Licorice-root, Calder's	*Ligusticum calderi*	AK	Plant	BS
Lily, Adobe	*Fritillaria pluriflora*	CA	Plant	BS
Lily, Western	*Lilium occidentale*	CA, OR	Plant	FE
Limpet, Banbury Springs	*Lanx* sp.	ID	Snail	FE
Linanthus, Little San Bernardino Mtn	*Gilia maculata*	CA	Plant	BS
Linanthus, Mount Tedoc	*Linanthus nuttallii* ssp. *howellii*	CA	Plant	BS
Linanthus, Orcutt's	*Linanthus orcuttii*	CA	Plant	BS
Liverwort	*Chiloscyphus gemmiparus*	OR	Plant	BS
Liverwort	*Jamesoniella autumnalis heterostips*	OR	Plant	BS
Liverwort	*Sphaerocarpos hians*	OR	Plant	BS
Lizard, Blunt-nosed Leopard	*Gambelia silus*	CA	Reptile	FE
Lizard, California Horned	*Phrynosoma coronatum frontale*	CA	Reptile	BS
Lizard, Coachella Valley Fringe-toed	*Uma inornata*	CA	Reptile	FT
Lizard, Colorado Desert Fringe-toed	*Uma notata notata*	CA	Reptile	BS
Lizard, Cowle's Fringe-toed	*Uma notata rufopunctata*	AZ	Reptile	BS
Lizard, Desert Night	*Xantusia vigilis vigilis*	UT	Reptile	BS
Lizard, Desert Spiny	*Sceloporus magister*	UT	Reptile	BS
Lizard, Flat-tailed Horned	*Phrynosoma mcallii*	AZ, CA, CO	Reptile	BS
Lizard, Longnose Leopard	*Gambelia wislizenii*	CA	Reptile	BS
Lizard, Mojave Black-collared	*Crotaphytus bicinctores*	ID, UT	Reptile	BS

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Lizard, Mojave Fringe-toed	*Uma scoparia*	CA	Reptile	BS
Lizard, Northern Sagebrush	*Sceloporus graciosus graciosus*	AZ, CA	Reptile	BS
Lizard, Sand Dune	*Sceloporus arenicolus*	NM	Reptile	C
Lizard, Short-horned	*Phrynosoma doublassii*	NV	Reptile	BS
Lizard, Sierra Alligator	*Elgaria coerulea palmeri*	NV	Reptile	BS
Lizard, Texas Horned	*Phrynosoma cornutum*	AZ, CO, NM	Reptile	BS
Lizard, Utah Night	*Xantusia vigilis utahensis*	UT	Reptile	BS
Lobelia, Kalm's	*Lobelia kalmii*	WA	Plant	BS
Lobelia, Water	*Lobelia dortmanna*	WA	Plant	BS
Locoweed, Arctic	*Oxytropis arctica* var. *barnebyana*	AK	Plant	BS
Locoweed, Kobuk	*Oxytropis kobukensis*	AK	Plant	BS
Loeflingia, Sagebrush	*Loeflingia squarrosa* var. *artemisiarum*	CA	Plant	BS
Lomatium, Congdon's	*Lomatium congdonii*	CA	Plant	BS
Lomatium, Cook's (Desert Parsley)	*Lomatium cookii*	OR	Plant	FE
Lomatium, Ochoco	*Lomatium ochocense*	OR	Plant	BS
Lomatium, Owens Peak	*Lomatium shevockii*	CA	Plant	BS
Lomatium, Suksdorf's	*Lomatium suksdorfii*	OR	Plant	BS
Lompoc, Yerba Santa	*Eriodictyon capitatum*	CA	Plant	FE
Loon, Common	*Gavia immer*	MT	Bird	BS
Loon, Red-throated	*Gavia stellata*	AK	Bird	BS
Lotus, Red-flowered	*Lotus rubriflorus*	CA	Plant	BS
Lotus, Scrub	*Lotus argyraeus* var. *multicaulis*	NV	Plant	BS
Lousewort, Dwarf	*Pedicularis centranthera*	CA	Plant	BS
Lousewort, Hairy	*Pedicularis hirsuta*	AK	Plant	BS
Lousewort, Meadow	*Pedicularis crenata*	MT	Plant	BS
Lupine, Cutler's Spured	*Lupinus caudatus* ssp. *culteri*	UT	Plant	BS
Lupine, Holmgren	*Lupinus holmgrenianus*	NV	Plant	BS
Lupine, Inch-high	*Lupinus uncialis*	CA, ID	Plant	BS
Lupine, Kincaid's	*Lupinus sulphureus* ssp. *kincaidii* (=*Lupinus sulphureus* var. *kincaidii)*	OR, WA	Plant	FT
Lupine, Orange	*Lupinus citrinus* var. *citrinus*	CA	Plant	BS
Lupine, Panamint Mountains	*Lupinus magnificus* var. *magnificus*	CA	Plant	BS
Lupine, Paradox Valley	*Lupinus crassus*	CO	Plant	BS
Lupine, Quincy	*Lupinus dalesiae*	CA	Plant	BS
Lupine, Sabine's	*Lupinus sabinianus*	WA	Plant	BS
Lupine, San Luis	*Lupinus ludovicianus*	CA	Plant	BS
Lupine, Shaggyhair	*Lupinus spectabilis*	CA	Plant	BS
Lynx, Canada	*Lynx canadensis*	AK, CO, ID, MT, OR, UT, WY	Mammal	FT
Madia, Showy	*Madia radiata*	CA	Plant	BS
Malacothrix, Carmel Valley	*Malacothrix saxatilis* var. *arachnoidea*	CA	Plant	BS
Mallow, Carmel Valley Bush	*Malacothamnus palmeri involucratus*	CA	Plant	BS
Mallow, Kern	*Eremalche parryi* ssp. *kernensis (=E. kernensis)*	CA	Plant	FE
Manzanita, Arroyo de la Cruz	*Arctostaphylos cruzensis*	CA	Plant	BS
Manzanita, Hooker's	*Arctostaphylos hookeri* ssp. *hookeri*	CA	Plant	BS
Manzanita, Ione	*Arctostaphylos myrtifolia*	CA	Plant	FT
Manzanita, Klamath	*Arctostaphylos klamathensis*	CA	Plant	BS
Manzanita, Monterey	*Arctostaphylos montereyensis*	CA	Plant	BS
Manzanita, Morro	*Arctostaphylos morroensis*	CA	Plant	FT

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Manzanita, Nissenan	*Arctostaphylos nissenana*	CA	Plant	BS
Manzanita, Otay	*Arctostaphylos otayensis*	CA	Plant	BS
Manzanita, Sand Mesa	*Arctostaphylos rudis*	CA	Plant	BS
Manzanita, Sandmat	*Arctostaphylos pumila*	CA	Plant	BS
Manzanita, Santa Margarita	*Arctostaphylos pilosula*	CA	Plant	BS
Marcescent Dudleya	*Dudleya cymosa* ssp. *marcescens*	CA	Plant	FT
Mariposa Lily, Alkali	*Calochortus striatus*	CA, NV	Plant	BS
Mariposa Lily, Broad-fruit	*Calochortus nitidus*	ID, OR	Plant	BS
Mariposa Lily, Crinite	*Calochortus coxii*	OR	Plant	BS
Mariposa Lily, Green-band	*Calochortus macrocarpus* var. *maculosus*	ID, OR	Plant	BS
Mariposa Lily, Greene's	*Calochortus greenei*	CA, OR	Plant	BS
Mariposa Lily, Inyo	*Calochortus excavatus*	CA	Plant	BS
Mariposa Lily, Pleasant Valley	*Calochortus clavatus* var. *avius*	CA	Plant	BS
Mariposa Lily, San Luis	*Calochortus obispoensis*	CA	Plant	BS
Mariposa Lily, San Luis Obispo	*Calochortus simulans*	CA	Plant	BS
Mariposa Lily, Shasta River	*Calochortus monanthus*	CA	Plant	BS
Mariposa Lily, Siskiyou	*Calochortus persistens*	CA, OR	Plant	C
Mariposa Lily, Umpqua	*Calochortus umpquaensis*	OR	Plant	C
Marsh Thistle, Wright's	*Cirsium wrightii*	NM	Plant	BS
Marten	*Martes americana*	UT	Mammal	BS
Martin, Purple	*Progne subis*	MT, OR	Bird	BS
Massasauga	*Sistrurus catenatus*	CO	Reptile	BS
Meadowfoam, Bellinger's	*Limnanthes floccosa* ssp. *bellingeriana*	CA, OR	Plant	BS
Meadowfoam, Butte County	*Limnanthes floccosa* ssp. *californica*	CA	Plant	FE
Meadowfoam, Slender	*Limnanthes gracilis* ssp. *gracilis*	OR	Plant	BS
Meadowfoam, Large-flowered Wooly	*Limnanthes floccosa* ssp. *grandiflora*	OR	Plant	FE
Meadowlark, Western	*Sturnella neglecta*	OR	Bird	BS
Meadowrue, Alpine	*Thalictrum alpinum*	MT	Plant	BS
Meadowrue, Purple	*Thalictrum dasycarpum*	ID	Plant	BS
Meesia	*Meesia longiseta*	CA	Insect	BS
Mesa-mint, Otay	*Pogogyne nudiuscula*	CA	Plant	FE
Mescal Bean, Guadalupe	*Sophora gypsophila* var. *guadalupensis*	NM	Plant	BS
Microseris, Detling's	*Microseris laciniata* ssp. *detlingii*	CA, OR	Plant	BS
Milk-vetch, Applegate's	*Astragalus applegatei*	OR	Plant	FE
Milk-vetch, Ames' (Suksdorf's Milk-vetch)	*Astragalus pulsiferae* var. *suksdorfii*	CA, OR	Plant	BS
Milk-vetch, Aquarius	*Astragalus newberryi* var. *aquarii*	AZ	Plant	BS
Milk-vetch, Ash Meadows	*Astragalus phoenix*	NV	Plant	FT
Milk-vetch, Ash Valley	*Astragalus anxius*	CA	Plant	BS
Milk-vetch, Barren	*Astragalus cusickii* var. *sterilis*	ID	Plant	BS
Milk-vetch, Barr's	*Astragalus barrii*	MT, SD	Plant	BS
Milk-vetch, Bitterroot	*Astragalus scaphoides*	MT	Plant	BS
Milk-vetch, Black (Black Woolly-pod Milk-vetch)	*Astragalus funereus*	CA, NV	Plant	BS
Milk-vetch, Brandegee	*Astragalus brandegeei*	CO	Plant	BS
Milk-vetch, Braunton's	*Astragalus brauntonii*	CA	Plant	FE
Milk-vetch, Challis	*Astragalus amblytropis*	ID	Plant	BS
Milk-vetch, Cisco	*Astragalus sabulosus* var. *sabulosus*	UT	Plant	BS

Common Name	Scientific Name	State	Class	Status[1]
Milk-vetch, Cisco	*Astragalus sabulosus* var. *vehiculus*	UT	Plant	BS
Milk-vetch, Cliff	*Astragalus cremnophylax* var. *myriorraphis*	AZ	Plant	BS
Milk-vetch, Clokey	*Astragalus aequalis*	NV	Plant	BS
Milk-vetch, Coachella Valley	*Astragalus lentiginosus* var. *coachellae*	CA	Plant	FE
Milk-vetch, Columbia	*Astragalus columbianus*	OR	Plant	BS
Milk-vetch, Cotton's	*Astragalus cottonii*	WA	Plant	BS
Milk-vetch, Cronquist	*Astragalus cronquistii*	CO, UT	Plant	BS
Milk-vetch, Currant	*Astragalus uncialis*	NV, UT	Plant	BS
Milk-vetch, Cushenbury	*Astragalus albens*	CA	Plant	FE
Milk-vetch, Cushion	*Astragalus aretioides*	CO, MT	Plant	BS
Milk-vetch, Darwin Mesa	*Astragalus atratus* var. *mensanus*	CA	Plant	BS
Milk-vetch, Deane's	*Astragalus deanei*	CA	Plant	BS
Milk-vetch, Debeque	*Astragalus debequaeus*	CO	Plant	BS
Milk-vetch, Debris	*Astragalus detritalis*	CO	Plant	BS
Milk-vetch, Deseret	*Astragalus desereticus*	UT	Plant	FT
Milk-vetch, Diamond Butte	*Astragalus toanus* var. *scidulus*	AZ	Plant	BS
Milk-vetch, Drummond's	*Astragalus drummondii*	ID	Plant	BS
Milk-vetch, Dubois	*Astragalus gilviflorus* var. *purpureus*	WY	Plant	BS
Milk-vetch, Duchesne	*Astragalus duchesnensis*	CO	Plant	BS
Milk-vetch, Escarpment	*Astragalus striatoflorus*	UT	Plant	BS
Milk-vetch, Ferris's	*Astragalus tener* var. *ferrisiae*	CA	Plant	BS
Milk-vetch, Ferron	*Astragalus musiniensis*	CO	Plant	BS
Milk-vetch, Field	*Astragalus agrestis*	CA	Plant	BS
Milk-vetch, Fish Slough	*Astragalus lentiginosus* var. *piscinensis*	CA	Plant	FT
Milk-vetch, Fisher Tower's	*Astragalus piscator*	CO	Plant	BS
Milk-vetch, Four-wing	*Astragalus tetrapterus*	ID	Plant	BS
Milk-vetch, Geyer's	*Astragalus geyeri* var. *geyeri*	CA	Plant	BS
Milk-vetch, Gilman	*Astragalus gilmanii*	NV	Plant	BS
Milk-vetch, Goose Creek	*Astragalus anserinus*	ID, NV, UT	Plant	BS
Milk-vetch, Grand Junction	*Astragalus linifolius*	CO	Plant	BS
Milk-vetch, Gray's	*Astragalus grayi*	MT	Plant	BS
Milk-vetch, Green River	*Astragalus pubentissimus*	UT	Plant	BS
Milk-vetch, Gumbo	*Astragalus ampullaris*	UT	Plant	BS
Milk-vetch, Gunnison	*Astragalus anisus*	CO	Plant	BS
Milk-vetch, Halfring	*Astragalus mohavensis* var. *hemigyrus*	NV	Plant	BS
Milk-vetch, Hamilton's	*Astragalus hamiltonii*	UT	Plant	BS
Milk-vetch, Heliotrope	*Astragalus limnocharis* var. *montii (=A. montii)*	UT	Plant	FT
Milk-vetch, Holmgren	*Astragalus holmgreniorum*	AZ, UT	Plant	FE
Milk-vetch, Horseshoe	*Astragalus desperatus* var. *neeseae (= A. equisolensis)*	UT	Plant	BS
Milk-vetch, Huachuca	*Astragalus hypoxylus*	AZ	Plant	BS
Milk-vetch, Humbolt	*Astragalus agnicidus*	CA	Plant	BS
Milk-vetch, Hyattville	*Astragalus jejunus* var. *articulatus*	WY	Plant	BS
Milk-vetch, Inyo	*Astragalus inyoensis*	NV	Plant	BS
Milk-vetch, Jacumba	*Astragalus douglasii* var. *perstrictus*	CA	Plant	BS
Milk-vetch, Jepson's	*Astragalus rattanii* var. *jepsonianus*	CA	Plant	BS
Milk-vetch, Kerr's	*Astragalus kerrii*	NM	Plant	BS
Milk-vetch, Knight's	*Astragalus knightii*	NM	Plant	BS
Milk-vetch, Lamoille Canyon	*Astragalus robbinsii* var. *occidentalis*	NV	Plant	BS

Common Name	Scientific Name	State	Class	Status[1]
Milk-vetch, Lane Mountain	*Astragalus jaegerianus*	CA	Plant	FE
Milk-vetch, Least Bladdery	*Astragalus microcystis*	ID	Plant	BS
Milk-vetch, Lemhi	*Astragalus aquilonius*	ID	Plant	BS
Milk-vetch, Lemmon's	*Astragalus lemmonii*	CA	Plant	BS
Milk-vetch, Lens-pod	*Astragalus lentiformis*	CA	Plant	BS
Milk-vetch, Lesser Rushy	*Astragalus convallarius* var. *convallarius*	MT	Plant	BS
Milk-vetch, Lonesome (Weak Milk-vetch)	*Astragalus solitarius*	NV	Plant	BS
Milk-vetch, Long Valley	*Astragalus johannis-howellii*	CA	Plant	BS
Milk-vetch, Lost River	*Astragalus amnis-amissi*	ID	Plant	BS
Milk-vetch, Mancos	*Astragalus humillimus*	CO, NM	Plant	FE
Milk-vetch, Marble Canyon	*Astragalus cremnophylax* var. *hevronii*	AZ	Plant	BS
Milk-vetch, Meadow	*Astragalus diversifolius*	ID	Plant	BS
Milk-vetch, Mokiak	*Astragalus mokiacensis*	NV	Plant	BS
Milk-vetch, Mourning	*Astragalus atratus* var. *inseptus*	ID	Plant	BS
Milk-vetch, Mulford's	*Astragalus mulfordiae*	ID	Plant	BS
Milk-vetch, Naturita	*Astragalus naturitensis*	CO	Plant	BS
Milk-vetch, Needle Mountains (Peck Station Milk-vetch)	*Astragalus eurylobus*	NV	Plant	BS
Milk-vetch, Nelson	*Astragalus nelsonianus*	CO, WY	Plant	BS
Milk-vetch, Newberry's	*Astragalus newberryi* var. *castoreus*	ID	Plant	BS
Milk-vetch, Osgood Mountains	*Astragalus yoder-williamsii*	ID	Plant	BS
Milk-vetch, Osterhout	*Astragalus osterhoutii*	CO	Plant	FE
Milk-vetch, Packard's	*Astragalus cusickii* var. *packardiae*	ID	Plant	BS
Milk-vetch, Painted	*Astragalus ceramicus* var. *apus*	MT	Plant	BS
Milk-vetch, Payson's	*Astragalus paysonii*	ID	Plant	BS
Milk-vetch, Picabo	*Astragalus oniciformis*	ID	Plant	BS
Milk-vetch, Peirson's	*Astragalus magdalenae* var. *peirsonii*	CA	Plant	FT
Milk-vetch, Plains	*Astragalus gilviflorus*	ID	Plant	BS
Milk-vetch, Pohill's	*Astragalus lentiginosus* var. *pohilli*	UT	Plant	BS
Milk-vetch, Precocious	*Astragalus proimanthus*	WY	Plant	BS
Milk-vetch, Pulsifer's	*Astragalus pulsiferae* var. *pulsiferae*	CA	Plant	BS
Milk-vetch, Railhead	*Astragalus terminalis*	ID, MT	Plant	BS
Milk-vetch, Ripley's	*Astragalus ripleyi*	CO, NM	Plant	BS
Milk-vetch, San Rafeal	*Astragalus rafaelensis*	CO	Plant	BS
Milk-vetch, Sandstone	*Astragalus sesquiflorus*	CO	Plant	BS
Milk-vetch, Shevock's	*Astragalus shevockii*	CA	Plant	BS
Milk-vetch, Shivwitz	*Astragalus eremiticus (= A. ampullariodes)*	UT	Plant	FE
Milk-vetch, Silver	*Astragalus subcinereus*	UT	Plant	BS
Milk-vetch, Silverleaf	*Astragalus argophyllus* var. *argophyllus*	CA	Plant	BS
Milk-vetch, Skiff	*Astragalus microcymbus*	CO	Plant	BS
Milk-vetch, Spine-noded	*Peteria thompsoniae*	ID	Plant	BS
Milk-vetch, Spring Mountain	*Astragalus remotus*	NV	Plant	BS
Milk-vetch, Starveling	*Astragalus jejunus* var. *jejunus*	CO, ID	Plant	BS
Milk-vetch, Suksdorf	*Astragalus pulsiferae* var. *suksdorfii*	CA, WA	Plant	BS
Milk-vetch, Three-cornered	*Astragalus geyeri* var. *triquetrus*	AZ	Plant	BS
Milk-vetch, Tiehm's	*Astragalus tiehmii*	CA, NV	Plant	BS
Milk-vetch, Tonopah	*Astragalus pseudiodanthus*	CA	Plant	BS
Milk-vetch, Toquima	*Astragalus toquimanus*	NV	Plant	BS

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Milk-vetch, Trelease's	*Astragalus racemosus* var. *treleasei*	WY	Plant	BS
Milk-vetch, Triple-ribbed	*Astragalus tricarinatus*	CA	Plant	FE
Milk-vetch, Trout Creek	*Astragalus salmonis*	ID	Plant	BS
Milk-vetch, Two-grooved	*Astragalus bisulcatus* var. *bisulcatus*	ID	Plant	BS
Milk-vetch, Walker Pass	*Astragalus ertterae*	CA	Plant	BS
Milk-vetch, Webber's	*Astragalus webberi*	CA	Plant	BS
Milk-vetch, Whited's	*Astragalus sinuatus*	OR	Plant	BS
Milk-vetch, Wind River	*Astragalus oreganus*	MT	Plant	BS
Milk-vetch, Zuni	*Astragalus accumbens*	NM	Plant	BS
Milkweed, Dwarf	*Asclepias uncialis*	CO	Plant	BS
Milkweed, Narrowleaf	*Asclepias stenophylla*	MT	Plant	BS
Milkweed, Ruth's	*Asclepias uncialis* ssp. *ruthiae*	NV	Plant	BS
Milkweed, Welsh's	*Asclepias welshii*	AZ, UT	Plant	FT
Milkwort, Mescalero	*Polygala rimuicola* var. *mescalerorum*	NM	Plant	BS
Miner's-candle, Owl Creek	*Cryptantha subcapitata*	WY	Plant	BS
Minnow, Loach	*Rhinichthys cobitis*	AZ, NM	Fish	FT
Minnow, Rio Grande Silvery	*Hybognathus amarus*	NM	Fish	FE
Mistmaiden, Thompson	*Romanzoffia thompsonii*	OR	Plant	BS
Mole, Coast	*Scapanus orarius*	ID	Mammal	BS
Monardella, Crisp	*Monardella crispa*	CA	Plant	BS
Monardella, Flax-like	*Monardella linoides oblonga*	CA	Plant	BS
Monardella, Robison	*Monardella robisonii*	CA	Plant	BS
Monardella, San Benito	*Monardella antonia* ssp. *benitensis*	CA	Plant	BS
Monardella, San Luis Obispo	*Monardella frutescens*	CA	Plant	BS
Monardella, Sweet-smelling	*Monardella beneolens*	CA	Plant	BS
Monardella, Veiny	*Monardella douglasii* ssp. *venosa*	CA	Plant	BS
Monkeyflower, Calico	*Mimulus pictus*	CA	Plant	BS
Monkeyflower, Disappearing	*Mimulus evanescens*	CA, OR	Plant	BS
Monkeyflower, Dwarf Purple	*Mimulus nanus*	MT	Plant	BS
Monkeyflower, Eastwood's	*Mimulus eastwoodiae*	CO	Plant	BS
Monkeyflower, Kaweah	*Mimulus norrisii*	CA	Plant	BS
Monkeyflower, Liverwort	*Mimulus jungermannioides*	OR	Plant	BS
Monkeyflower, Membrane-leaved	*Mimulus hymenophyllus*	OR	Plant	BS
Monkeyflower, Mojave	*Mimulus mohavensis*	CA	Plant	BS
Monkeyflower, Shevock's	*Mimulus shevockii*	CA	Plant	BS
Monkeyflower, Slender-stalked	*Mimulus gracilipes*	CA	Plant	BS
Monkeyflower, Slender-stemmed	*Mimulus filicaulis*	CA	Plant	BS
Monkeyflower, Spacious	*Mimulus washingtonensis*	ID	Plant	BS
Monkeyflower, Square-stemmed	*Mimulus ringens*	MT	Plant	BS
Moonpod, Desert	*Selinocarpus diffusus*	AZ	Plant	BS
Moonpod, Goosefoot	*Ammocodon chenopodioides*	AZ	Plant	BS
Moon-shrub, Northern	*Dendriscocaulon intricatulum*	CA	Plant	BS
Moonwort, Mingan	*Botrychium minganense*	ID	Plant	BS
Moonwort, Northern	*Botrychium pinnatum*	ID	Plant	BS
Moonwort, Scalloped (Dainty Moonwort)	*Botrychium crenulatum*	CA, NV, OR	Plant	BS
Moonwort, Slender	*Botrychium lineare*	CO, ID, OR	Plant	C
Moonwort, Stalked	*Botrychium pedunculosum*	OR	Plant	BS
Moonwort, Twin-spiked	*Botrychium paradoxum*	OR	Plant	BS
Moonwort; Upward-lobed	*Botrychium ascendens*	AK, OR	Plant	BS
Morning-glory, Butte County	*Calystegia atriplicifolia* ssp. *buttensis*	CA	Plant	BS

Common Name	Scientific Name	State	Class	Status[1]
Morning-glory, South Coast Range	*Calystegia collina* ssp. *venusta*	CA	Plant	BS
Morning-glory, Stebbins'	*Calystegia stebbinsii*	CA	Plant	FE
Moss	*Encalypta brevicolla crumiana*	OR	Bryophyte	BS
Moss	*Limbella fryei*	OR	Plant	BS
Moss, Gold Butte	*Didymodon nevadensis*	NV	Plant	BS
Moss, Worm	*Scorpidium scorpioides*	MT	Plant	BS
Moth, Kern Primrose Sphinx	*Euproserpinus euterpe*	CA	Insect	FT
Mountain Balm, Indian Knob	*Eriodictyon altissimum*	CA	Plant	FE
Mountain-parsley, Purple	*Oreonana purpurascens*	CA	Plant	BS
Mountainsnail, Mineral Creek	*Oreohelix pilsbryi*	NM	Snail	BS
Mountainsnail, Ogden Deseret	*Oreohelix periphera*	UT	Snail	C
Mouse, Cactus	*Peromyscus torridus*	UT	Mammal	BS
Mouse, Dark Kangaroo	*Microdipodops megacephalus*	ID	Mammal	BS
Mouse, Desert Valley Kangaroo	*Microdipodops megacephalus albiventer*	NV	Mammal	BS
Mouse, Fletcher Dark Kangaroo	*Microdipodops megacephalus nasutus*	NV	Mammal	BS
Mouse, Little Pocket	*Perognathus longimembris*	ID	Mammal	BS
Mouse, Meadow Jumping	*Zapus hudsonius*	MT	Mammal	BS
Mouse, New Mexican Jumping	*Zapus hudsonius luteus*	NM	Mammal	BS
Mouse, Northern Rock	*Peromyscus nasutus*	UT	Mammal	BS
Mouse, Olive-backed Pocket	*Perognathus fasciatus*	UT	Mammal	BS
Mouse, Preble's Meadow Jumping	*Zapus hudsonius preblei*	CO, WY	Mammal	FT
Mouse, Rock Pocket	*Chaetodipus intermedius*	UT	Mammal	BS
Mouse, San Joaquin Pocket	*Perognathus inornatus inornatus*	CA	Mammal	BS
Mouse, Southern Grasshopper	*Onychomys torridus*	UT	Mammal	BS
Mouse, Tulare Grasshopper	*Onychomys torridus tularensis*	CA	Mammal	BS
Mouse, Yellow-eared Pocket	*Perognathus xanthonotus*	CA	Mammal	BS
Mousetail, Ostler's	*Ivesia shockleyi* var. *ostleri*	UT	Plant	BS
Mousetail, Sessile	*Myosurus sessilis*	OR	Plant	BS
Mudwort, Chiricahua	*Limosella pubiflora*	NM	Plant	BS
Muhly, Hairy	*Muhlenbergia villiflora* var. *villosa*	NM	Plant	BS
Mule ears, El Dorado	*Wyethia reticulata*	CA	Plant	BS
Murrelet, Kittliz's	*Brachyramphus brevirostris*	AK	Bird	BS
Murrelet, Marbled	*Brachyramphus marmoratus marmoratus*	CA, OR, WA	Bird	FT
Mushroom, Little Brown	*Clitocybe subditopoda*	CA	Fungi	BS
Mushroom, Little Brown	*Hydropus marginellus*	CA	Fungi	BS
Mushroom, Little Brown	*Mycena quinaultensis*	CA	Fungi	BS
Mushroom, Little Green	*Dermocybe humboldtensis*	CA, OR	Fungi	BS
Musk-root	*Adoxa moschatellina*	MT, SD	Plant	BS
Muskrat, Pecos River	*Ondatra zibethicus ripensis*	NM	Mammal	BS
Myotis, California	*Myotis californicus*	ID	Mammal	BS
Myotis, Cave	*Myotis velifer*	AZ, CA, NM, NV	Mammal	BS
Myotis, Fringed	*Myotis thysanodes*	AZ, CA, CO, ID, NM, NV, UT, WY	Mammal	BS
Myotis, Little Brown	*Myotis lucifugus*	NV	Mammal	BS
Myotis, Long-eared	*Myotis evotis*	AZ, CA, NM, NV, WY	Mammal	BS
Myotis, Long-legged	*Myotis volans*	AZ, NM, NV	Mammal	BS
Myotis, Small-footed (Western	*Myotis ciliolabrum*	AZ, CA, ID,	Mammal	BS

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Small-footed Myotis)		NM, NV		
Myotis, Yuma	*Myotis yumanensis*	CA, CO, ID, NM	Mammal	BS
Nama	*Nama densum*	MT	Plant	BS
Naucorid, Ash Meadows	*Ambrysus amargosus*	NV	Insect	FT
Navarretia, Baker's	*Navarretia leucocephala* ssp. *bakeri*	CA	Plant	BS
Navarretia, Marigold	*Navarretia tagetina*	OR	Plant	BS
Navarretia, Piute Mountains	*Navarretia setiloba*	CA	Plant	BS
Navarretia, Willamette	*Navarretia willamettensis*	OR	Plant	BS
Necklacepod, Western	*Sophora leachiana*	OR	Plant	BS
Needle, Giant Spanish	*Palafoxia arida* var. *gigantea*	CA	Plant	BS
Needlegrass, Green	*Nassella viridula*	ID	Plant	BS
Needlegrass, Guadalupe	*Achnatherum curvifolium*	NM	Plant	BS
Neoparrya, Rock Loving	*Neoparrya lithophila*	CO	Plant	BS
Neststraw, Mason	*Stylocline masonii*	CA	Plant	BS
Neststraw, Oil	*Stylocline citroleum*	CA	Plant	BS
Night-blooming Cactus, Desert	*Peniocereus greggii* var. *greggii*	NM	Plant	BS
Nighthawk, Common	*Chordeiles minor*	OR	Bird	BS
Niterwort, Amargosa	*Nitrophila mohavensis*	CA, NV	Plant	FE
Northern-rockcress, Low	*Braya humulis*	MT	Plant	BS
Nuthatch, Pygmy	*Sitta pygmaea*	OR	Bird	BS
Nymph, Big Smoky Wood	*Cercyonis oetus alkalorum*	NV	Insect	BS
Nymph, Pallid Wood	*Cercyonis oetus pallescens*	NV	Insect	BS
Nymph, White River Wood	*Cercyonis pegala carsonensis*	NV	Insect	BS
Oak, Bur	*Quercus macrocarpa*	MT	Plant	BS
Ocelot	*Felis pardalis*	AZ	Mammal	FE
Onion, Aase's	*Allium aaseae*	ID	Plant	BS
Onion, Geyers	*Allium geyeri* var. *chatterleyi*	UT	Plant	BS
Onion, Goodding's	*Allium gooddingii*	NM	Plant	BS
Onion, Jepson's	*Allium jepsonii*	CA	Plant	BS
Onion, Munz's	*Allium munzii*	CA	Plant	FE
Onion, Parish's	*Allium parashii*	AZ	Plant	BS
Onion, Rawhide Hill	*Allium tuolumnense*	CA	Plant	BS
Onion, Spanish Needle	*Allium shevockii*	CA	Plant	BS
Onion, Tolmie's	*Allium tolmiei*	ID	Plant	BS
Onion, Two-headed	*Allium anceps*	ID	Plant	BS
Orache, Earlmart	*Atriplex erecticaulis*	CA	Plant	BS
Orache, Subtle	*Atriplex subtilis*	CA	Plant	BS
Orange Peel Fungus, Stalked	*Sowerbyella rhenana*	CA	Fungi	BS
Orchid, Chatterbox	*Epipactis gigantea*	ID	Plant	BS
Orchid, Western Prairie Fringed	*Platanthera praeclara*	ND, NE, SD, WY	Plant	FT
Orchid, Yellow Wide-lip	*Liparis loeselii*	OR	Plant	BS
Orchis, Round-leaf	*Amerorchis rotundifolia*	MT	Plant	BS
Oryctes	*Oycytes nevadensis*	NV	Plant	BS
Orthocarpus, Shasta	*Orthocarpus pachystachyus*	CA	Plant	BS
Orthotrichium, Hall's	*Orthotrichium hallii*	ID	Plant	BS
Orthotrichium, Shevock's	*Orthotrichium shevockii*	CA	Plant	BS
Osprey	*Pandion haliaetus*	UT	Bird	BS
Otter, Northern River	*Lutra canadensis*	UT, WY	Mammal	BS
Otter, River	*Lutra canadensis lataxina*	AZ, NM,	Mammal	BS

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		NV, WY		
Otter, Southwestern River	*Lutra canadensis sonora*	NM	Mammal	BS
Owl, Boreal	*Aegolius funereus*	MT	Bird	BS
Owl, Burrowing (Western Owl)	*Athene cunicularia hypugaea*	AZ, CA, MT, NM, NV, OR, UT, WY	Bird	BS
Owl, California Spotted	*Strix occidentalis occidentalis*	CA	Bird	BS
Owl, Flammulated	*Otus flammeolus*	ID, MT, NV, OR	Bird	BS
Owl, Great Gray	*Strix nebulosa*	MT, OR	Bird	BS
Owl, Long-eared	*Asio otus*	NV	Bird	BS
Owl, Mexican Spotted	*Strix occidentalis lucida*	AZ, CA, CO, NM, UT	Bird	FT
Owl, Northern Spotted	*Strix occidentalis caurina*	CA, OR	Bird	FT
Owl, Short-eared	*Asio flammeus*	ID, NV, UT	Bird	BS
Owl's-clover, Fleshy	*Castilleja campestris* ssp. *succulenta*	CA	Plant	FT
Owl's-clover, Humbolt Bay	*Castilleja ambigua* ssp. *humboltiensis*	CA	Plant	BS
Owl's-clover, Rosy	*Orthocarpus bracteosus*	OR	Plant	BS
Oxytheca, Cushenbury	*Nassella viridula*	CA	Plant	FE
Paddlefish	*Polyodon spathula*	MT	Fish	BS
Paintbrush, Aquarius	*Castilleja aquariensis*	UT	Plant	C
Paintbrush, Fraternal	*Castilleja fraterna*	OR	Plant	BS
Paintbrush, Golden	*Castellija levisecta*	OR, WA	Plant	FT
Paintbrush, Green-tinged	*Castilleja chlorotica*	OR	Plant	BS
Paintbrush, Mendocino Coast (Indian Paintbrush)	*Castilleja mendocinensis*	CA, OR	Plant	BS
Paintbrush, Obispo	*Castilleja densiflora* ssp. *obispoensis*	CA	Plant	BS
Paintbrush, Ornate	*Castilleja ornata*	NM	Plant	BS
Paintbrush, Purple Alpine	*Castilleja rubida*	OR	Plant	BS
Paintbrush, Steens Mountain	*Castilleja pilosa* var. *steenensis*	OR	Plant	BS
Panicgrass, Scribner's	*Dichanthelium oligosanthes* var. *scribnerianum*	MT	Plant	BS
Paronychia, Ahart's	*Paronychia ahartii*	CA	Plant	BS
Peaclam, Montane	*Pisidium ultramontanum*	OR	Snail	BS
Pearpod, Talapoosa Peak	*Stroganowia tiehmii*	NV	Plant	BS
Peavine, Thin-leaved	*Lathyrus holochlorus*	OR, WA	Plant	BS
Pebblesnail, Casebeer	*Fluminicola* sp. *nov.*	OR	Snail	BS
Pebblesnail, Columbia	*Fluminicola columbianus*	ID	Snail	BS
Pebblesnail, Diminutive	*Fluminicola* sp.	OR	Snail	BS
Pebblesnail, Fall Creek	*Fluminicola* sp.	OR	Snail	BS
Pebblesnail, Keene Creek	*Fluminicola* sp.	OR	Snail	BS
Pebblesnail, Klamath	*Fluminicola* sp.	OR	Snail	BS
Pebblesnail, Klamath Rim	*Fluminicola* sp.	OR	Snail	BS
Pebblesnail, Lake of the Woods	*Fluminicola* sp.	OR	Snail	BS
Pebblesnail, Newrite	*Fluminicola* sp.	OR	Snail	BS
Pebblesnail, Tigerlily	*Fluminicola* sp.	OR	Snail	BS
Pebblesnail, Toothed	*Fluminicola* sp.	OR	Snail	BS
Pelican, American White	*Pelecanus erthrorhynchos*	CO, ID, UT	Bird	BS
Pelican, Brown	*Pelecanus occidentalis*	AZ, CA, OR	Bird	FE
Pennycress, Meadow	*Thlaspi parviflorum*	MT	Plant	BS
Pennyroyal, Todsen's	*Hedeoma todsenii*	NM	Plant	FE

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Penstemon, Barrett's	*Penstemon barrettiae*	OR, WA	Plant	BS
Penstemon, Blowout	*Penstemon haydenii*	WY	Plant	FE
Penstemon, Idaho	*Penstemon idahoensis*	ID, UT	Plant	BS
Penstemon, Janish's	*Penstemon janishiae*	ID	Plant	BS
Penstemon, Lemhi	*Penstemon lemhiensis*	ID, MT	Plant	BS
Penstemon, Peck's	*Penstemon peckii*	OR	Plant	BS
Penstemon, Pinyon	*Penstemon pinorum*	UT	Plant	BS
Pentachaeta, Slender	*Pentachaeta exilis* ssp. *aeolica*	CA	Plant	BS
Peppergrass, Borrego Valley	*Lepidium flavum felipense*	CA	Plant	BS
Peppergrass, Davis'	*Lepidium davisii*	ID	Plant	BS
Peppergrass, Entire-leaved	*Lepidium integrifolium* var. *integrifolium*	WY	Plant	BS
Peppergrass, Huber's	*Lepidium huberi*	UT	Plant	BS
Peppergrass, Jared's	*Lepidium jaredii* ssp. *jaredii*	CA	Plant	BS
Peppergrass, Mountain	*Lepidium montanum* var. *claronense*	UT	Plant	BS
Peppergrass, Ostler's	*Lepidium ostleri*	UT	Plant	BS
Peppergrass, Panoch	*Lepidium jaredii* ssp. *album*	CA	Plant	BS
Peppergrass, Slickspot	*Lepidium papilliferum*	ID	Plant	PT
Ridge-cress, Barneby	*Lepidium barnebyanum*	UT	Plant	FE
Phacelia, Atwood's	*Phacelia pulchella* var. *atwoodii*	UT	Plant	BS
Phacelia, Cinder	*Phacelia serrata*	NM	Plant	BS
Phacelia, Clay	*Phacelia argillacea*	UT	Plant	FE
Phacelia, Cooke's	*Phacelia cookei*	CA	Plant	BS
Phacelia, Cronquist's	*Phacelia cronquistiana*	UT	Plant	BS
Phacelia, Death Valley Round-leaved	*Phacelia mustelina*	ID	Plant	BS
Phacelia, Debeque	*Phacelia submutica*	CO	Plant	C
Phacelia, Drab	*Phacelia indecora*	UT	Plant	BS
Phacelia, Least (Dwarf Phacelia)	*Phacelia minutissima*	ID, NV, OR	Plant	BS
Phacelia, Hoary	*Phacelia incana*	ID	Plant	BS
Phacelia, Mackenzie's	*Phacelia lutea* var. *mackenzieorum*	OR	Plant	BS
Phacelia, Malheur Yellow	*Phacelia lutea* var. *calva*	ID	Plant	BS
Phacelia, Mono (Mono County Phacelia)	*Phacelia monoensis*	CA, NV	Plant	BS
Phacelia, Mount Diablo	*Phacelia phacelioides*	CA	Plant	BS
Phacelia, Nash's	*Phacelia nashiana*	CA	Plant	BS
Phacelia, Nine Mile Canyon	*Phacelia novenmillensis*	CA	Plant	BS
Phacelia, North Park	*Phacelia formosula*	CO	Plant	FE
Phacelia, Obscure	*Phacelia inconspicua*	ID	Plant	BS
Phacelia, Parish (Playa Phacelia)	*Phacelia parishii*	AZ, CA, NV	Plant	BS
Phacelia, Playa	*Phacelia inundata*	CA, OR, UT	Plant	BS
Phacelia, Scott Valley	*Phacelia greenei*	CA	Plant	BS
Phacelia, Silvery	*Phacelia argentea*	OR	Plant	BS
Phacelia, Siskiyou	*Phacelia leonis*	CA, OR	Plant	BS
Phacelia, Sticky	*Phacelia lenta*	OR	Plant	BS
Phacelia, Utah	*Phacelia utahensis*	UT	Plant	BS
Phaeocollybia	*Phaeocollybia gregaria*	OR	Fungi	BS
Phaeocollybia	*Phaeocollybia oregonensis*	OR	Fungi	BS
Phaeocollybia	*Phaeocollybia pseudofestiva*	CA	Fungi	BS
Phaeocollybia	*Phaeocollybia scatesiae*	CA	Fungi	BS
Phaeocollybia	*Phaeocollybia spadicea*	CA	Fungi	BS
Phaeocollybia, California	*Phaeocollybia californica*	CA, OR	Fungi	BS

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Phaeocollybia, Olive	*Phaeocollybia olivacea*	CA, OR	Fungi	BS
Phaeocollybia, Spruce	*Phaeocollybia piceae*	CA	Fungi	BS
Phainopepla	*Phainopepla nitens*	NV, OR	Bird	BS
Phlox, Beaver Rim	*Phlox pungens*	WY	Plant	BS
Phlox, Eureka	*Phlox hirsuta*	CA	Plant	FE
Phlox, Plains	*Phlox andicola*	MT	Plant	BS
Physa (Snail), Hotspring	*Physella* sp.	OR	Snail	BS
Physa (Snail), Rotund	*Physella columbiana*	OR	Snail	BS
Pika	*Ochotona princeps*	UT	Mammal	BS
Pikeminnow (Squawfish), Colorado	*Ptychocheilus lucius*	AZ, CA, CO, NM, UT, WY	Fish	FE, XN
Pincushion, Desert	*Chaenactis stevioides*	ID	Plant	BS
Pincushion Cactus, Brady	*Pediocactus bradyi*	AZ	Plant	FE
Pincushion Cactus, Cochise	*Escobaria robbinsorum (=Coryphantha robbinsorum)*	AZ	Plant	FT
Pincushion Cactus, Kaibab	*Pediocactus paradinei*	AZ	Plant	BS
Pincushion Cactus, Lee's	*Escobaria sneedii* var. *leei (= Coryphantha sneedii* var. *leei)*	NM	Plant	FT
Pincushion Cactus, Nye	*Sclerocactus nyensis*	NV	Plant	BS
Pincushion Cactus, Organ Mountains	*Escobaria organensis*	NM	Plant	BS
Pincushion Cactus, San Andres	*Escobaria sandbergii*	NM	Plant	BS
Pincushion Cactus, Schlesser's	*Scleroccactus schlesseri*	NV	Plant	BS
Pincushion Cactus, Siler	*Pediocactus sileri*	AZ, UT	Plant	FT
Pincushion Cactus, Sneed's	*Escobaria sneedii* var. *sneedii (= Coryphantha sneedii* var. *sneedii)*	NM	Plant	FE
Pincushion Cactus, Spiny Star	*Escobaria vivipara*	ID	Plant	BS
Pincushion Cactus, Villard's	*Escobaria villardii*	NM	Plant	BS
Pine, Washoe	*Pinus washoensis*	NV	Plant	BS
Pitcher-sage, Gander's	*Lepechinia ganderi*	CA	Plant	BS
Plover, Mountain	*Charadrius montanus*	AZ, CA, CO, MT, NM, NV, OR, UT, WY	Bird	BS
Plover, Piping	*Charadrius melodus*	CO, MT, ND, NE, NM, SD, WY	Bird	FT
Plover, Western Snowy	*Charadrius alexandrinus nivosus*	AZ, CA, CO, NM, NV, OR, UT, WA, WY	Bird	FT
Podistera, Yukon	*Podistera yukonensis*	AK	Plant	BS
Pogogyne, Profuse-flowered	*Pogogyne floribunda*	CA, OR	Plant	BS
Polemonium, Great	*Polemonium carneum*	OR	Plant	BS
Polemonium, Washington	*Polemonium pectinatum*	OR	Plant	BS
Polypore, Blue-capped	*Albatrellus flettii*	CA	Fungi	BS
Polypore, Blue-pored	*Albatrellus caeruleoporus*	CA	Fungi	BS
Polypore, Noble	*Bridgeoporus nobilissimus*	OR	Plant	BS
Pondsnail, Bonneville	*Stagnicola bonnevillensis*	UT	Snail	C
Poolfish, Pahrump	*Empetrichthys latos*	NV	Fish	FE
Popcornflower, Coral Seeded	*Plagiobothrys figuratus* ssp. *corallicarpa*	OR	Plant	BS
Popcornflower, Hooked	*Plagiobothrys uncinatus*	CA	Plant	BS
Popcornflower, Rough	*Plagiobothrys hirtus*	OR	Plant	FE

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Popcornflower, Slender-branched	*Plagiobothrys leptocladus*	MT	Plant	BS
Poppy, Diamond-petaled California	*Eschscholzia rhombipetala*	CA	Plant	BS
Poppy, Red Rock	*Eschscholzia minutiflora* ssp. *twisselmanii*	CA	Plant	BS
Poreleaf, Pygmy	*Porophyllum pygmaeum*	NV	Plant	BS
Prairie Chicken, Lesser	*Tympanuchus pallidicinctus*	CO, NM	Bird	C
Prairie-clover, Albuquerque	*Dalea scariosa*	NM	Plant	BS
Prairie-clover, Canyonlands	*Dalea flavescens*	UT	Plant	BS
Prairie Dog, Arizona Black-tailed	*Cynomys ludovicianus arizonensis*	NM	Mammal	C
Prairie Dog, Black-tailed	*Cynomys ludovicianus*	AZ, CO, ID, MT, NM, WY	Mammal	C
Prairie Dog, Gunnison's	*Cynomys gunnisoni*	NM	Mammal	BS
Prairie Dog, Utah	*Cynomys parvidens*	UT	Mammal	FT
Prairie Dog, White-tailed	*Cynomys leucurus*	UT, WY	Mammal	BS
Prairie Rocket, Narrow-leaved	*Erysimum angustatum*	AK	Plant	BS
Prickly phlox, Bruneau River	*Leptodactylon glabrum*	ID, NV	Plant	BS
Prickly phlox, Hazel's	*Leptodactylon pungens*	ID, OR	Plant	BS
Prickly phlox, Mat	*Leptodactylon caespitosum*	MT	Plant	BS
Pricklypear, Blue Diamond	*Opuntia* x *multigeniculata (encinocarpa* x *whipplei)*	AZ	Plant	BS
Pricklypear, Sand (El Paso Pricklypear)	*Opuntia polyacantha* var. *arenaira)*	NM	Plant	C
Prickly poppy, Sacramento	*Argemone pleiacantha* ssp. *pinnatisecta*	NM	Plant	FE
Primrose, Alkali	*Primula alcalina*	ID	Plant	BS
Primrose, Bering Dwarf	*Douglasia beringensis*	AK	Plant	BS
Primrose, Greenland	*Primula egaliksensis*	CO	Plant	BS
Primrose, House Range	*Primula cusickiana*	UT	Plant	BS
Primrose, Maguire	*Pisidium ultramontanum*	OR	Plant	BS
Primrose, Maguire	*Primula maguirei*	UT	Plant	FT
Primrose, Mealy	*Primula incana*	MT, ND	Plant	BS
Princesplume, Malheur (Oregon Princesplume; Perenial Princesplume)	*Stanleya confertiflora*	ID, OR	Plant	BS
Pronghorn, Sonoran	*Antilocapra americana sonoriensis*	AZ	Mammal	FE
Pseudoscorpion, Malheur	*Apochthonius malheuri*	OR	Arachnid	BS
Pupfish, Amargosa River	*Cyprinodon nevadensis amargosae*	CA	Fish	BS
Pupfish, Ash Meadows Amargosa	*Cyprinodon nevadensis mionectes*	NV	Fish	FE
Pupfish, Desert	*Cyprinodon macularius*	AZ, CA	Fish	FE
Pupfish, Devil's Hole	*Cyprinodon diabolis*	NV	Fish	FE
Pupfish, Owens	*Cyprinodon radiosus*	CA	Fish	FE
Pupfish, Pecos	*Cyprinodon pecosensis*	NM	Fish	C
Pupfish, Warm Springs	*Cyprinodon nevadensis pectoralis*	NV	Fish	FE
Pupfish, White Sands	*Cyprinodon tularosa*	NM	Fish	BS
Purpusia, Rock	*Ivesia arizonica* var. *saxosa*	NV	Plant	BS
Pussytoes, Meadows	*Antennaria arcuata*	NV, WY	Plant	BS
Pygmy-owl, Cactus Ferruginous	*Glaucidium brasilianum cactorum*	AZ	Bird	FE
Pygmy-owl, Northern (Blue Mountains Pygmy-owl)	*Glaucidium gnoma*	OR	Bird	BS
Pygmy Poppy, White	*Canbya candida*	CA	Plant	BS
Pyrg, Bifid Duct	*Pyrgulopsis peculariaris*	NV	Snail	BS
Pyrg, Big Warm Spring	*Pyrgulopsis papillata*	NV	Snail	BS

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Pyrg, Carinate Duckwater	*Pyrgulopsis carinata*	NV	Snail	BS
Pyrg, Chupadera	*Pyrgulopsis chupaderae*	NM	Snail	C
Pyrg, Dixie Valley	*Pyrgulopsis dixensis*	NV	Snail	BS
Pyrg, Duckwater	*Pyrgulopsis aloba*	NV	Snail	BS
Pyrg, Elongate Cain Spring	*Pyrgulopsis augusta*	NV	Snail	BS
Pyrg, Elongate Mud Meadows	*Pyrgulopsis notidicola*	NV	Snail	BS
Pyrg, Fly Ranch	*Pyrgulopsis bruesi*	NV	Snail	BS
Pyrg, Gila	*Pyrgulopsis gilae*	NM	Snail	C
Pyrg, Humbolt	*Pyrgulopsis humboldtensis*	NV	Snail	BS
Pyrg, Landyes	*Pyrgulopsis landeyi*	NV	Snail	BS
Pyrg, Large-gland Carico	*Pyrgulopsis basiglans*	NV	Snail	BS
Pyrg, Northern Soldier Meadow	*Pyrgulopsis militaris*	NV	Snail	BS
Pyrg, Oasis Valley	*Pyrgulopsis micrococcus*	NV	Snail	BS
Pyrg, Ovate Cain Spring	*Pyrgulopsis pictilis*	NV	Snail	BS
Springsnail, Socorro	*Pyrgulopsis neomexicana*	NM	Snail	FE
Pyrg, Souther Soldier Meadow	*Pyrgulopsis umbilicata*	NV	Snail	BS
Pyrg, Southern Duckwater	*Pyrgulopsis anatina*	NV	Snail	BS
Pyrg, Southern Steptoe	*Pyrgulopsis sulcata*	NV	Snail	BS
Pyrg, Spring Mountain	*Pyrgulopsis deaconi*	NV	Snail	BS
Pyrg, Squat Mud Meadows	*Pyrgulopsis limaria*	NV	Snail	BS
Pyrg, Sub-glubose Steptoe Ranch	*Pyrgulopsis orbiculata*	NV	Snail	BS
Pyrg, Transverse Gland	*Pyrgulopsis cruciglans*	NV	Snail	BS
Pyrg, Wongs	*Pyrgulopsis wongi*	NV	Snail	BS
Quail, Mountain	*Oreortyx pictus*	ID, NV	Bird	BS
Queen-of-the-forest	*Filipendula occidentalis*	OR, WA	Plant	BS
Rabbit, Pygmy	*Brachylagus idahoensis*	CA, ID, MT, NV, UT, WY	Mammal	BS
Rabbit, Pygmy (Columbia Basin Distinct Population Segment)	*Brachylagus idahoensis*	OR	Mammal	FE
Rabbit, Pygmy (EmE = Washington; PE = Washington)	*Brachylagus idahoensis*	OR	Mammal	BS
Rabbitbrush, Guadalupe	*Ericameria nauseosus* ssp. *texensis*	NM	Plant	BS
Rabbitbrush, Remote (Pintwater Rabbitbrush)	*Chrysothamnus eremobius*	NV	Plant	BS
Ragwort, Cut-leaf	*Packera moresbiensis*	AK	Plant	BS
Ragwort, Cut-leaved	*Packera eurycephalus* var. *lewisrosei*	CA	Plant	BS
Ragwort, Few Flowered	*Packera pauciflora*	CO	Plant	BS
Ragwort, Red Hills	*Packera clevelandii*	CA	Plant	BS
Ragwort, Western	*Packera hesperia*	OR	Plant	BS
Rail, Yellow	*Coturnicops noveboracensis*	OR	Bird	BS
Rail, Yuma Clapper	*Rallus longirostris yumanensis*	AZ, CA, NV	Bird	FE
Raillardella, Muir's	*Raillardiopsis muirii*	CA	Plant	BS
Raillardella, Showy	*Raillardella pringlei*	CA	Plant	BS
Ramshorn (Snail), Great Basin	*Helisoma (Carinifex) newberryi newberryi*	OR	Snail	BS
Ramshorn, Borax Lake	*Planorbella oregonensis*	NM, OR	Snail	BS
Raspberry, Northwest	*Rubus nigerrimus*	OR	Plant	BS
Rat, Chisel-toothed Kangaroo	*Dipodomys microps celsus*	UT	Mammal	BS
Rat, Desert Kangaroo	*Dipodomys deserti*	UT	Mammal	BS
Rat, Fresno Kangaroo	*Dipodomys nitraoides exilis*	CA	Mammal	FE
Rat, Giant Kangaroo	*Dipodomys ingens*	CA	Mammal	FE

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Rat, House Rock Valley Chisel-toothed Kangaroo	*Dipodomys microps leucotis*	AZ	Mammal	BS
Rat, Marysville Kangaroo	*Dipodomys californicus eximius*	CA	Mammal	BS
Rat, Merriam's Kangaroo	*Dipodomys merriami*	UT	Mammal	BS
Rat, Morro Bay Kangaroo	*Dipodomys heermani morroensis*	CA	Mammal	FE
Rat, Short-nosed Kangaroo	*Dipodomys nitratoides brevinasus*	CA, WY	Mammal	BS
Rat, Stephens' Kangaroo	*Dipodomys stephensi* (incl. *D. cascus*)	CA	Mammal	FE
Rat, Tipton Kangaroo	*Dipodomys nitratoides nitratoides*	CA	Mammal	FE
Rattlesnake, Midget Faded	*Crotalus viridis concolor*	CO, WY	Reptile	BS
Rattlesnake, Mojave	*Crotalus scutulatus scutulatus*	UT	Reptile	BS
Rattlesnake, New Mexican Ridge-nosed	*Crotalus willardi obscurus*	AZ, NM	Reptile	FT
Rattlesnake, Southwestern Speckled	*Crotalus mitchellii pyrrhus*	UT	Reptile	BS
Rattleweed, San Diego	*Astragalus oocarpus*	CA	Plant	BS
Reedgrass, Cascade	*Calamagrostis tweedyi*	ID	Plant	BS
Reed-mustard, Barneby	*Schoenocrambe barnebyi*	UT	Plant	FE
Reed-mustard, Clay	*Schoenocrambe argillacea*	UT	Plant	FT
Reed-mustard, Shrubby	*Glaucocarpun suffrutescens (=Schoenocrambe suffrutescens)*	UT	Plant	FE
Ricegrass, Henderson's	*Achnatherum hendersonii*	OR	Plant	BS
Ricegrass, Little	*Piptatherum exiguum*	CA	Plant	BS
Ricegrass, Small-flowered	*Piptatherum micranthum*	ID	Plant	BS
Ricegrass, Wallowa	*Achnatherum wallowensis*	OR	Plant	BS
Ringtail	*Bassariscus astutus*	NM, UT	Mammal	BS
Roach, Red Hills	*Lavinia symmetricus* ssp.	CA	Fish	BS
Rock-brake, Slender	*Cryptogramma stelleri*	CO	Plant	BS
Rockcress, Bodie Hills	*Arabis bodiensis*	CA, NV	Plant	BS
Rockcress, Crandall	*Arabis crandallii*	CO	Plant	BS
Rockcress, Crater Lake	*Arabis suffrutescens* var. *horizontalis*	OR	Plant	BS
Rockcress, Daggett	*Arabis demissa* var. *languida*	MT	Plant	BS
Rockcress, Elko	*Arabis falcifructa*	NV	Plant	BS
Rockcress, Grouse Creek	*Arabis falcatoria*	NV	Plant	BS
Rockcress, Hell's Canyon	*Arabis hastatula*	OR	Plant	BS
Rockcress, Koehler's	*Arabis koehleri* var. *koehleri*	OR	Plant	BS
Rock-cress, McDonald's	*Arabis mcdonaldiana*	CA, OR	Plant	FE
Rockcress, Ophir Pass	*Arabis ophira*	NV	Plant	BS
Rockcress, Park	*Arabis fernaldiana* var. *fernaldiana*	CO, UT	Plant	BS
Rockcress, Sapphire	*Arabis fecunda*	MT	Plant	BS
Rockcress, Small	*Arabis pusilla*	WY	Plant	BS
Rock-daisy, Alcove	*Perityle specuicola*	UT	Plant	BS
Rock-daisy, Black	*Townsendia smithii*	AZ	Plant	BS
Rock-daisy, Clifton	*Perityle ambrosiifolia*	AZ	Plant	BS
Rock-daisy, Hanapah	*Perityle villosa*	CA	Plant	BS
Rock-daisy, New Mexico	*Perityle staurophylla* var. *staurophylla*	NM	Plant	BS
Rock-daisy, Nodding	*Perityle cernua*	NM	Plant	BS
Rockmat, Chelan	*Petrophyton cinerascens*	WA	Plant	BS
Rockress, Kass	*Draba kassii*	UT	Plant	BS
Rock-rose, Diablo	*Helianthella castanea*	CA	Plant	BS
Rock-tansey	*Sphaeromeria capitata*	CO	Plant	BS
Rose, Grand Canyon	*Rosa stellata* ssp. *abyssa*	AZ	Plant	BS
Rosewood, Arizona Sonoran	*Vauquelinia californica* ssp. *sonorensis*	AZ	Plant	BS

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Rosewood, Limestone	*Vauquelinia californica* ssp. *pauciflora*	NM	Plant	BS
Rubberweed, Cooper's	*Hymenoxys cooperi* var. *canescens*	ID	Plant	BS
Rubberweed, Stone	*Hymenoxys lapidicola*	UT	Plant	BS
Rupertia, Hall's	*Rupertia hallii*	CA	Plant	BS
Rush, Kellogg's	*Juncus kelloggii*	WA	Plant	BS
Rush, Red Bluff Dwarf	*Juncus leiospermus* var. *leiospermus*	CA	Plant	BS
Rush, Tiehm's	*Juncus tiehmii*	OR	Plant	BS
Rush-lily, Purple-flowered	*Hastingsia bracteosa* var. *atropurpurea*	OR	Plant	BS
Sage, Aravaipa	*Salvia amissa*	AZ	Plant	BS
Sage, Chicken	*Sphaeromeria argentea*	MT	Plant	BS
Sage, Clokey Mountain (Clokey Purple Sage)	*Salvia dorrii* ssp. *dorrii* var. *clokeyi*	NV	Plant	BS
Sagebrush, Laramie False	*Sphaeromeria simplex*	WY	Plant	BS
Sagebrush, Porter's	*Artemisia porteri*	WY	Plant	BS
Sage-grouse, Greater	*Centrocercus urophasianus*	CA, CO, ID, MT, NV, OR, UT, WY	Bird	BS
Sage-grouse, Gunnison	*Centrocercus minimus*	CO, UT	Bird	C
Salamander, California Tiger	*Ambystoma californiense*	CA	Amphibian	FT
Salamander, Coeur d'Alene	*Plethodon idahoensis*	ID	Amphibian	BS
Salamander, Columbia Torrent	*Rhyacotriton kezeri*	OR	Amphibian	BS
Salamander, Desert Slender	*Batrachoseps aridus*	CA	Amphibian	FE
Salamander, Idaho Giant	*Dicamptodon aterrimus*	ID	Amphibian	BS
Salamander, Inyo Mountains Slender	*Batrachoseps campi*	CA	Amphibian	BS
Salamander, Oregon Slender	*Batrachoseps wrighti*	OR	Amphibian	BS
Salamander, Sonora Tiger	*Ambystoma tigrinum stebbinsi*	AZ	Amphibian	FE
Salamander, Tehachapi Slender	*Batrachoseps stebbinsi*	CA	Amphibian	BS
Salamander, Yellow-blotched	*Ensatina eschscholtzi croceator*	CA	Amphibian	BS
Salmon, Beaver Creek chinook	*Onconhynchus tshawytscha*	AK	Fish	BS
Salmon, Chinook (California Coastal ESU[2])	*Oncorhynchus tshawytscha*	CA	Fish	FT
Salmon, Chinook (Central Valley ESU)	*Oncorhynchus tshawytscha*	CA, ID	Fish	C
Salmon, Chinook (Fall Lower Columbia River ESU)	*Oncorhynchus tshawytscha*	OR	Fish	FT
Salmon, Chinook (Fall Snake River Run ESU)	*Oncorhynchus tshawytscha*	ID, OR	Fish	FT
Salmon, Chinook (Lower Columbia River ESU)	*Oncorhynchus tshawytscha*	OR	Fish	FT
Salmon, Chinook (Spring Central Valley Run ESU)	*Oncorhynchus tshawytscha*	CA	Fish	FT
Salmon, Chinook (Spring/Summer Snake River ESU)	*Oncorhynchus tshawytscha*	ID, OR	Fish	FT
Salmon, Chinook (Upper Columbia River Spring Run ESU)	*Oncorhynchus tshawytscha*	OR	Fish	FE
Salmon, Chinook (Upper Willamette ESU)	*Oncorhynchus tshawytscha*	OR	Fish	FT
Salmon, Chinook (Winter Sacramento River Run ESU)	*Oncorhynchus tshawytscha*	CA, OR	Fish	FE
Salmon, Chum	*Oncorhynchus keta*	OR	Fish	BS
Salmon, Chum (Columbia River ESU)	*Oncorhynchus keta*	OR	Fish	FT

Common Name	Scientific Name	State	Class	Status[1]
Salmon, Chum (Summer Hood Canal Run ESU)	*Oncorhynchus keta*	OR	Fish	FT
Salmon, Clear Creek Chum	*Onocnhynchus keta*	AK	Fish	BS
Salmon, Coho (Central California Coast ESU)	*Oncorhynchus kisutch*	CA, OR	Fish	FT
Salmon, Coho (Lower Columbia River/Southwest Washington ESU)	*Oncorhynchus kisutch*	OR	Fish	FT
Salmon, Coho (Oregon Coast ESU)	*Oncorhynchus kisutch*	OR	Fish	FT
Salmon, Coho (Southern Oregon/Northern California Coasts ESU)	*Oncorhynchus kisutch*	CA, OR	Fish	FT
Salmon, Fall Chinook	*Oncorhynchus tshawytscha*	OR	Fish	FT
Salmon, Sockeye (Snake River, Idaho Stock ESU)	*Oncorhynchus nerka*	OR, ID	Fish	FE
Saltbush, Giant Four-wing	*Atriplex canescens* var. *gigantea*	UT	Plant	BS
Saltbush, Griffith's	*Atriplex griffithsii*	NM	Plant	BS
Saltbush, Heart-leaved	*Atriplex cordulata*	CA	Plant	BS
Saltbush, Lost Hills	*Atriplex vallicola*	CA	Plant	BS
Sand-food	*Pholisma sonorae*	AZ	Plant	BS
Sand-food, Blue	*Triteleiopsis palmeri*	AZ	Plant	BS
Sand-food, Scaly	*Pholisma arenarium*	AZ	Plant	BS
Sandpaper-plant	*Petalonyx parryi*	UT	Plant	BS
Sandpaper-plant, Death Valley	*Petalonyx thurberi* ssp. *gilmanii*	CA	Plant	BS
Sandpiper, Buff-breasted	*Tryngites subruficollis*	AK	Bird	BS
Sandpiper, Upland	*Bartramia longicauda*	ID, OR	Bird	BS
Sand-verbena, Pink	*Abronia umbellata* ssp. *breviflora*	CA	Plant	BS
Sandwort, Howell's	*Minuartia howellii*	CA	Plant	BS
Sandwort, Marsh	*Arenaria paludicola*	OR	Plant	FE
Sandwort, Nuttall	*Minuartia nuttallii*	CO	Plant	BS
Sandwort, Scott Mountain	*Minuartia stolonifera*	CA	Plant	BS
Sapsucker, Red-naped	*Sphyrapicus nuchalis*	NV	Bird	BS
Sapsucker, Williamson's	*Sphyrapicus thryoideus*	ID, UT	Bird	BS
Sauger	*Stizostedion canadense*	MT	Fish	BS
Saw-wort, Weber	*Saussurea weberi*	CO	Plant	BS
Saxifrage, Aleutian	*Saxifraga aleutica*	AK	Plant	BS
Scalebroom, Gypsum	*Lepidospartum burgessii*	NM	Plant	BS
Scarab, Aegialian Beetle	*Aegialia knighti*	NV	Insect	BS
Scarab, Big Dune Aphodius	*Aphodius* sp.	NV	Insect	BS
Scarab, Crescent Dune Aegialian	*Aegialia crescenta*	NV	Insect	BS
Scarab, Crescent Dune Aphodius	*Aphodius* sp.	NV	Insect	BS
Scarab, Crescent Dune Serican	*Serica ammomensico*	NV	Insect	BS
Scarab, Guiliani's Dune	*Pseudocotalpa guilianii*	NV	Insect	BS
Scarab, Hardy's Aegialian	*Aegialia hardyi*	NV	Insect	BS
Scarab, Humboltd Serican	*Serica humboldti*	NV	Insect	BS
Scarab, Sand Mountain Aphodius	*Aphodius* sp.	NV	Insect	BS
Scarab, Sand Mountain Serican	*Serica psamnobunus*	NV	Insect	BS
Scorpion Plant, Beatley	*Phacelia beatleyae*	NV	Plant	BS
Scoter, Black	*Melanitta nigra*	AK	Bird	BS
Scoter, Surf	*Melanitta perspicillata*	AK	Bird	BS
Sculpin, Bear Lake	*Cottus extensus*	ID	Fish	BS
Sculpin, Malheur Mottled	*Cottus bendirei*	OR	Fish	BS

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Sculpin, Shoshone	*Cottus greenei*	ID	Fish	BS
Sculpin, Wood River	*Cottus leiopomus*	ID	Fish	BS
Scurfpea, Three-nerved	*Pediomelum trinervatum*	AZ	Plant	BS
Sea turtle, Leatherback	*Dermochelys coriacea*	AK	Reptile	FE
Seal, Harbor	*Phoca vitulina concolor*	AK	Mammal	BS
Sea-lion, Steller	*Eumetopias jubatus*	AK (West of Cape Suckling), CA, OR	Mammal	FE
Sea-lion, Steller	*Eumetopias jubatus*	AK (East of Cape Suckling)	Mammal	FT
Sedge, Bristly	*Carex comosa*	ID	Plant	BS
Sedge, Canadian Single Spike	*Carex scirpoidea*	CO	Plant	BS
Sedge, Craw's	*Carex crawei*	MT	Plant	BS
Sedge, Foothill	*Carex tumulicola*	ID	Plant	BS
Sedge, Giant	*Carex ultra*	AZ	Plant	BS
Sedge, Green	*Carex viridula*	CO	Plant	BS
Sedge, Idaho	*Carex idahoa*	ID, MT, OR	Plant	BS
Sedge, Indian Valley	*Carex parryana* var. *brevisquama*	ID	Plant	BS
Sedge, Livid	*Carex livida*	CO, ID	Plant	BS
Sedge, Low Northern	*Carex concinna*	CO	Plant	BS
Sedge, Navajo	*Carex specuicola*	UT	Plant	FT
Sedge, San Luis Obispo	*Carex obispoensis*	CA	Plant	BS
Sedge, Unnamed	*Carex nov*	OR	Plant	BS
Sedge, Western	*Carex occidentalis*	ID	Plant	BS
Sedge, Yellow	*Carex flava*	CO	Plant	BS
Sheep, Bighorn (Peninsular Ranges Bighorn)	*Ovis canadensis*	CA	Mammal	FE
Sheep, California Bighorn (Sierra Nevada Bighorn)	*Ovis canadensis californiana*	CA	Mammal	FE
Sheep, Desert Bighorn	*Ovis canadensis nelsoni*	CA, NV	Mammal	BS
Shield fern, Aleutian	*Polystichum aleuticum*	AK	Plant	FE
Shiner, Arkansas River	*Notropis girardi*	NM	Fish	FT
Shiner, Beautiful	*Cyprinella formosa*	AZ, NM	Fish	FT
Shiner, Pecos Bluntnose	*Notropis simus pecosensis*	NM	Fish	FT
Shiner, Rio Grande	*Notropis jemezanus*	NM	Fish	BS
Shiner, River	*Notropis blennius*	CO	Fish	BS
Shootingstar, Frigid	*Dodecatheon austrofrigidum*	OR, WA	Plant	BS
Shoshonea	*Shoshonea pulvinata*	MT, WY	Plant	BS
Shoulderband (Snail), Oregon	*Helminthoglypta hertleini*	OR	Snail	BS
Shrew, Arizona	*Sorex arizonae*	NM	Mammal	BS
Shrew, Buena Vista Lake Ornate	*Sorex ornatus relictus*	CA	Mammal	FE
Shrew, Dwarf	*Sorex nanus*	UT, WY	Mammal	BS
Shrew, Merriam's	*Sorex merriami*	MT	Mammal	BS
Shrew, Preble's	*Sorex preblei*	MT, NV	Mammal	BS
Shrike, Loggerhead	*Lanius ludovicianus*	AZ, ID, MT, NM, NV, WY	Bird	BS
Shrimp, Vernal Pool Tadpole	*Lepidurus packardi*	CA	Crustacean	FE
Sidalcea, Maple-leaved	*Sidalcea malachroides*	CA, OR	Plant	BS
Sideband (Snail), Columbia	*Monadenia fidelis columbiana*	OR	Snail	BS

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Sideband (Snail), Green	*Monadenia fidelis beryllica*	OR	Snail	BS
Sideband (Snail), Hairy Sierra	*Monadenia mormonum hirsuta*	CA	Snail	BS
Sideband (Snail), Keeled	*Monadenia circumcarinata*	CA	Snail	BS
Sideband (Snail), Modoc	*Monadenia* sp.	OR	Snail	BS
Sideband (Snail), Oregon/Dalles	*Monadenia fidelis minor*	OR	Snail	BS
Sideband (Snail), Travelling	*Monadenia fidelis celeuthia*	OR	Snail	BS
Sidewinder, Mojave Desert	*Crotalus cerastes cerastes*	UT	Reptile	BS
Silene, Seely's	*Silene seelyi*	OR	Plant	BS
Silverpuffs, Howell's	*Microseris howellii*	OR	Plant	BS
Skeletonweed, Dolores River	*Lygodesmia doloresensis*	CO, UT	Plant	BS
Skeletonweed, Rush Pink	*Lygodesmia entrada*	UT	Plant	BS
Skeletonweed, Thorn	*Stephanomeria spinosa*	MT	Plant	BS
Skink, Arizona	*Eumeces gilberti arizonensis*	AZ	Reptile	BS
Skink, Coronado	*Eumeces skiltonianus interparietalis*	CA	Reptile	BS
Skink, Many-lined	*Eumeces multivirgatus gaigeae*	UT	Reptile	BS
Skink, Western Red-tailed	*Eumeces gilberti rubricaudatus*	NV	Reptile	BS
Skipper, Ash Meadows Alkali	*Pseudocopaeodes eunus alinea*	NV	Insect	BS
Skipper, Carson Wandering	*Pseudocopaeodes eunus obscurus*	CA, NV	Insect	FE
Skipper, Dakota	*Hesperia dacotae*	MT	Insect	C
Skipper, Denio Sandhill	*Polites sabuleti sinemaculata*	NV	Insect	BS
Skipper, MacNeil Sootywing	*Hesperopsis gracielae*	AZ, NV	Insect	BS
Skipper, Mardon	*Polites mardon*	CA, NM, OR	Insect	C
Skipper, Mono Basin	*Hesperia uncas giulianii*	NV	Insect	BS
Skipper, Pawnee Montane	*Hesperia leonardus maontana*	CO	Insect	FT
Skipper, Railroad Valley	*Hesperia uncas fulvapalla*	NV	Insect	BS
Skipper, White Mountain	*Hesperia miriamae longaevicola*	NV	Insect	BS
Skipper, White River Valley	*Hesperia uncas grandiosa*	NV	Insect	BS
Skullcap, Dwarf	*Scutellaria nana*	CA	Plant	BS
Skunk, Spotted	*Spilogale putorius*	MT	Mammal	BS
Smooth-aster, Guadalupe	*Symphyotrichum laeve* var. *geyeri*	NM	Plant	BS
Smooth-aster, Jessica's	*Symphyotrichum jessicae*	ID, OR	Plant	BS
Smooth-aster, Rush	*Symphyotrichum boreale*	ID, OR	Plant	BS
Snail, Bliss Rapids	*Taylorconcha serpenticola*	ID	Snail	FT
Springsnail, Bruneau Hot	*Pyrgulopsis bruneauensis*	ID	Snail	FE
Snail, Disc (Oregonian Snail)	*Cryptomastix* sp.	OR	Snail	BS
Snail, Dona Ana Talus	*Sonorella todseni*	NM	Snail	BS
Snail, Hells Canyon Land	*Cryptomastix populi*	OR	Snail	BS
Snail, Idaho Spring	*Pyrgulopsis idahoenis*	ID	Snail	FE
Springsnail, Koster's	*Juturnia kosteri*	NM	Snail	FE
Snail, Mission Creek (Oregonian Snail)	*Cryptomastix magnidentata*	ID	Snail	BS
Snail, Morro Shoulderband	*Helminthoglypta walkeriana*	CA	Snail	FE
Snail, Mountain Boulder Pile	*Oreohlix jugalis*	ID	Snail	BS
Snail, Mountain Idaho Banded	*Orehelix idahoensis idahoensis*	ID	Snail	BS
Snail, Mountain Lava Rock	*Orhelix waltoni*	ID	Snail	BS
Snail, Mountain Whorled	*Orehelix vortex*	ID	Snail	BS
Snail, Newcomb's Littorine	*Algamorda subrotundata*	OR	Snail	BS
Snail, Pecos Assiminea	*Assiminea pecos*	NM	Snail	PE
Snail, Schell Creek Mountain	*Oreohelix nevadensis*	NV	Snail	BS
Snail, Snake River Physa	*Physa natricina*	ID	Snail	FE
Snail, Striate Mountain	*Orehelix strigosa goniogyra*	ID	Snail	BS

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Snail, Utah Valvata	*Valvata utahensis*	ID, UT	Snail	FE
Snails, Hydrobiid Spring	All species in genus *Pyrgulopsis*	AZ	Snail	BS
Snails, Hydrobiid Spring	All species in genus *Pyrgulopsis*	OR	Snail	BS
Snails, Succineid	All species in family Succineidae	AZ	Snail	BS
Snake, Common Garter	*Thamnophis sirtalis*	ID	Reptile	BS
Snake, Giant Garter	*Thamnophis gigas*	CA	Reptile	FT
Snake, Great Plains Rat	*Elaphe guttata emoryi*	UT	Reptile	BS
Snake, Longnose	*Rhinocheilus lecontei*	ID	Reptile	BS
Snake, Mexican Garter	*Thamnophis eques megalops*	NM	Reptile	BS
Snake, Milk	*Lampropeltis triangulum taylori*	CO, UT	Reptile	BS
Snake, Mojave Patch-nosed	*Salvadora hexalepis mojavensis*	UT	Reptile	BS
Snake, Narrowhead Garter	*Thamnophis rufipunctatus*	NM	Reptile	BS
Snake, Painted Desert Glossy	*Arizona elegans philipi*	UT	Reptile	BS
Snake, Sanora Lyre	*Trimorphodon biscutatus lambda*	UT	Reptile	BS
Snake, Smooth Green	*Opheodrys vernalis*	UT	Reptile	BS
Snake, Two-striped Garter	*Thamnophis hammondii*	CA	Reptile	BS
Snake, Utah Blind	*Leptotyphlops humilis utahensis*	UT	Reptile	BS
Snake, Western Ground	*Sonora semiannulata*	ID	Reptile	BS
Snow-wreath, Shasta	*Neviusia cliftonii*	CA	Plant	BS
Soaproot, Dwarf	*Chlorogalum pomeridianum* var. *minus*	CA	Plant	BS
Soaproot, Red Hills	*Chlorogalum grandiflorum*	CA	Plant	BS
Spadefoot, Great Basin	*Spea intermontana*	CO, WY	Amphibian	BS
Sparrow, Baird's	*Ammodramus bairdii*	MT, NM, WY	Bird	BS
Sparrow, Black-throated	*Amphispiza bilineata*	ID	Bird	BS
Sparrow, Brewer's	*Spizella breweri*	ID, WY	Bird	BS
Sparrow, Grasshopper	*Ammodramus savannarum*	UT	Bird	BS
Sparrow, Large-billed Savannah	*Passerculus sandwichensis rostratus*	AZ	Bird	BS
Sparrow, LeConte's	*Ammodramus leconteii*	MT	Bird	BS
Sparrow, Sage	*Amphispiza belli*	ID, MT, OR, WY	Bird	BS
Sparrow, Vesper (Oregon Sparrow)	*Pooecetes gramineus affinis*	NV, OR	Bird	BS
Spider-flower, Many Stemmed	*Cleome multicaulis*	CO, WY, NM	Plant	BS
Spikedace	*Meda fulgida*	AZ, NM	Fish	FT
Spinedace, Big Spring	*Lepidomeda mollispinis pratensis*	NV	Fish	FT
Spinedace, Little Colorado	*Lepidomeda vittata*	AZ	Fish	FT
Spinedace, Virgin River	*Lepidomeda mollispinis mollispinis*	NV, UT	Fish	BS
Spinedace, White River	*Lepidomeda albivalis*	NV	Fish	FE
Spineflower, Brewer's	*Chorizanthe breweri*	CA	Plant	BS
Spineflower, Indian Valley	*Aristocapsa insignis*	CA	Plant	BS
Spineflower, Monterey	*Chorizanthe pungens* var. *pungens*	CA	Plant	FT
Spineflower, Orcutt's	*Chorizanthe orcuttiana*	CA	Plant	FE
Spineflower, San Benito	*Chorizanthe biloba immemora*	CA	Plant	BS
Spineflower, Slender-horned	*Dodecahema leptoceras*	CA	Plant	FE
Spineflower, Straight-awned	*Chorizanthe rectispina*	CA	Plant	BS
Spleenwort, Dalhouse	*Asplenium [=Ceterach] dalhousiae*	AZ	Plant	BS
Splittail, Sacramento	*Pogonichthys macrolepidotus*	CA	Fish	FT
Springbeauty, Ogilvie Mountains	*Claytonia ogilviensis*	AK	Plant	BS
Springfish, Hiko White River	*Crenichthys baileyi grandis*	NV	Fish	FE
Springfish, Moapa White River	*Crenichthys baileyi moapae*	NV	Fish	BS
Springfish, Moorman White River	*Crenichthys baileyi thermophilus*	NV	Fish	BS
Springfish, Preston White River	*Crenichthys baileyi albivallis*	NV	Fish	BS

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Springfish, Railroad Valley	*Crenichthys nevadae*	NV	Fish	FT
Springfish, White River	*Crenichthys baileyi baileyi*	NV	Fish	FE
Spring-parsley, Featherleaf	*Cymopterus beckii*	UT	Plant	BS
Spring-parsley, Plains	*Cymopterus acaulis* var. *parvus*	UT	Plant	BS
Spring-parsley, Uinta Basin	*Cymopterus duchesnensis*	CO	Plant	BS
Springsnail, Alamosa	*Tryonia alamosae*	NM	Snail	FE
Springsnail, Crooked Creek	*Pyrgulopsis intermedia*	OR	Snail	BS
Springsnail, Harney Lake	*Pyrgulopsis hendersoni*	OR	Snail	BS
Springsnail, Idaho	*Fontelicella idahoensis*	ID	Snail	FE
Springsnail, Malheur Cave	*Oncopodura mala*	CA, OR	Snail	BS
Springsnail, Owyhee Hot	*Pyrgulopsis* sp.	OR	Snail	BS
Springsnail, Roswell	*Pyrgulopsis roswellensis*	NM	Snail	FE
Spruce, White	*Picea glauca*	ID	Plant	BS
Spurge, Flat-seeded	*Chamaesyce platysperma*	CA	Plant	BS
Spurge, Hoover's	*Chamaesyce hooveri*	CA	Plant	FT
Spurge, Paria	*Euphorbia nephradenia*	UT	Plant	BS
Spurge, Stony Creek	*Chamaesyce ocellata* ssp. *rattanii*	CA	Plant	BS
Squirrel, Coachella Valley Round-tailed Ground	*Spermophilus tereticaudus chlorus*	CA	Mammal	C
Squirrel, Ground Piaute	*Spermophilus mollis artemisae*	ID	Mammal	BS
Squirrel, Miriam's Ground	*Spermophilus canus vigilis*	ID	Mammal	BS
Squirrel, Northern Idaho Ground	*Spermophilus brunneus brunneus*	ID	Mammal	FT
Squirrel, Southern Idaho Ground	*Spermophilus brunneus*	ID	Mammal	C
Squirrel, Washington Ground	*Spermophilus washingtoni*	OR	Mammal	C
Squirrel, Wyoming Ground	*Spermophilus elegans nevadensis*	ID	Mammal	BS
St. John's-wort, Large Canadian	*Hypericum majus*	ID	Plant	BS
Star-tulip, Long-haired	*Calochortus longebarbatus longebarb*	CA, OR	Plant	BS
Star-tulip, Shirley Meadows	*Calochortus westonii*	CA	Plant	BS
Steelhead (Central California Coast)	*Oncorhynchus mykiss*	CA	Fish	FT
Steelhead (California Central Valley ESU)	*Oncorhynchus mykiss*	CA	Fish	FT
Steelhead (Klamath Mountains ESU)	*Oncorhynchus mykiss*	ID	Fish	C
Steelhead (Lower Columbia River ESU)	*Oncorhynchus mykiss*	OR	Fish	FT
Steelhead (Middle Columbia River ESU)	*Oncorhynchus mykiss*	OR	Fish	FT
Steelhead (Northern California ESU)	*Oncorhynchus mykiss*	CA	Fish	FT
Steelhead (Oregon Coast ESU)	*Oncorhynchus mykiss*	OR	Fish	C
Steelhead (Puget Sound ESU)	*Oncorhynchus mykiss*	OR	Fish	PT
Steelhead (Snake River Basin ESU)	*Oncorhynchus mykiss*	ID, OR	Fish	FT
Steelhead (South-central California Coast ESU)	*Oncorhynchus mykiss*	CA	Fish	FT
Steelhead (Southern California ESU)	*Oncorhynchus mykiss*	CA	Fish	FE
Steelhead (Upper Columbia River ESU)	*Oncorhynchus mykiss*	OR	Fish	FE
Steelhead (Upper Willamette River ESU)	*Oncorhynchus mykiss*	OR	Fish	FT
Steelhead, Gulkana	*Oncorhynchus mykiss*	AK	Fish	BS
Stenotus, Woolly	*Stenotus lanuginosus*	CA	Plant	BS
Stickleaf, Royal Gorge	*Mentzelia densa*	CO	Plant	BS
Stickleaf, September 11th	*Mentzelia memorabilis*	AZ	Plant	BS

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Stickleaf, Smooth	*Mentzelia mollis*	ID, NV	Plant	BS
Stickleaf, Southwest	*Mentzelia argillosa*	CO	Plant	BS
Stickleback, Unarmored Threespine	*Gasterosteus aculeatus williamsoni*	CA	Fish	FE
Stickseed, Cronquist's	*Hackelia cronquistii*	ID	Plant	BS
Stickseed, Deep Creek	*Hackelia ibapensis*	UT	Plant	BS
Stickseed, Rattlesnake	*Hackelia ophiobia*	ID	Plant	BS
Stickseed, Showy	*Hackelia venusta*	WA	Plant	FE
Stickweed, Rocky Mountain	*Cleomella palmeriana*	UT	Plant	BS
Stitchwort, James'	*Pseudostellaria jamesii*	MT	Plant	BS
Stonecat	*Noturus flavus*	CA, CO	Fish	BS
Stonecrop, Applegate	*Sedum oblanceolatum*	OR	Plant	BS
Stonecrop, Bartram	*Graptopetalum bartramii*	AZ	Plant	BS
Stonecrop, Canyon Creek	*Sedum paradisum*	CA	Plant	BS
Stonecrop, Feather River	*Sedum albomarginatum*	CA	Plant	BS
Stonecrop, Red Mountain	*Sedum eastwoodiae*	CA	Plant	C
Stonecrop, Rogue River	*Sedum moranii*	OR	Plant	BS
Stonefly, Wahkeena Falls Flightless	*Zapada wahkeena*	OR	Insect	BS
Strawberry, Idaho	*Waldsteinia idahoensis*	ID	Plant	BS
Streptanthus, Howell's	*Streptanthus howellii*	OR	Plant	BS
Sturgeon, Pallid	*Scaphirhynchus albus*	CO, MT, WY	Fish	FE
Sturgeon, White	*Acipenser transmontanus*	ID	Fish	BS
Sturgeon, White (Kootenai ESU)	*Acipenser transmontanus*	ID, MT	Fish	FE
Sucker, Blue	*Cycleptus elongatus*	MT, WY	Fish	BS
Sucker, Bluehead	*Catostomus discobolus*	CO, UT, WY	Fish	BS
Sucker, Desert	*Catostomus [=Pantosteus] clarki*	AZ, NM, UT	Fish	BS
Sucker, Flannelmouth	*Catostomus latipinnis*	CO, NV, UT, WY	Fish	BS
Sucker, Goose Lake	*Catostomus occidentalis lacusanserinus*	OR	Fish	BS
Sucker, June	*Chasmistes liorus*	UT	Fish	FE
Sucker, Little Colorado	*Catostomus* sp.	AZ, UT	Fish	BS
Sucker, Lost River	*Deltistes luxatus*	CA, OR	Fish	FE
Sucker, Modoc	*Catostomus microps*	CA	Fish	FE
Sucker, Mountain	*Catostomas platyrhynchus*	CO	Fish	BS
Sucker, Razorback	*Xyrauchen texanus*	AZ, CA, CO, NM, NV, UT, WY	Fish	FE
Sucker, Rio Grande	*Catostomus plebeius*	NM	Fish	BS
Sucker, Shortnose	*Chasmistes brevirostris*	CA, OR	Fish	FE
Sucker, Sonora	*Catostomus insignis*	AZ, NM	Fish	BS
Sucker, Wall Canyon	*Catostomus* sp.	NV	Fish	BS
Sucker, Warner	*Catostomus warnerensis*	CA, NV, OR	Fish	FT
Sucker, White River Desert	*Catostomus clarki intermedius*	NV	Fish	BS
Sullivantia, Oregon	*Sullivantia oregana*	OR	Plant	BS
Sullivantia, Wyoming	*Sullivantia hapermanii* var. *hapermanii*	MT	Plant	BS
Sumac, Kearney	*Rhus kearneyi*	AZ	Plant	BS
Sunburst, Hartweg's Golden	*Pseudobahia bahiifolia*	CA	Plant	FE
Sunburst, San Joaquin Adobe	*Pseudobahia peirsonii*	CA	Plant	FT
Suncup, Diamond Valley	*Camissionia gouldii*	UT	Plant	BS
Sunflower, Pecos	*Helianthus paradoxus*	NM	Plant	FT
Sunray, Ash Meadows	*Enceliopsis nudicaulis* var. *corrugata*	NV	Plant	FT
Sunray, Silverleaf	*Enceliopsis argophylla*	AZ, NV	Plant	BS

Common Name	Scientific Name	State	Class	Status[1]
Swan, Trumpeter	*Cygnus buccinator*	AK, ID, MT, WY	Bird	BS
Swertia, Umpqua	*Frasera fastigata*	OR	Plant	BS
Swertia, White River	*Frasera gypsicola*	UT	Plant	BS
Swift, Black	*Cypseloides niger*	ID, UT	Bird	BS
Tansy-aster, Gypsum Hotsprings	*Machaeranthera gypsitherma*	NM	Plant	BS
Tansymustard, Wyoming	*Descurainia torulosa*	WY	Plant	BS
Tarplant, Congdon's	*Hemizonia parryi* ssp. *congdonii*	CA	Plant	BS
Tarplant, Hall's	*Hemizonia halliana*	CA	Plant	BS
Tarplant, Otay	*Hemizonia cunjugens (=Deinandra conjugens)*	CA	Plant	FT
Tarplant, Tecate	*Hemizonia floribunda*	CA	Plant	BS
Tauschia, Hoover's	*Tauschia hooveri*	OR	Plant	BS
Tern, Black	*Chlidonias niger*	CO, ID, MT, NM, NV, UT	Bird	BS
Tern, Caspian	*Sterna caspia*	UT	Bird	BS
Tern, Least (Interior)	*Sterna antillarum*	CO, MT, NM, WY	Bird	FE
Tetracoccus, Parry's	*Tetracoccus dioicus*	CA	Plant	BS
Thelypody, Arrow	*Thelypodium sagittatum*	MT	Plant	BS
Thelypody, Howell's Spectacular	*Thelypodium howellii* ssp. *howellii*	CA	Plant	BS
Thelypody, Howell's Spectacular	*Thelypodium howellii* ssp. *spectabilis*	OR	Plant	FT
Thelypody, Northwestern	*Thelypodium paniculatum*	MT	Plant	BS
Thelypody, Wavy-leaf	*Thelypodium repandum*	ID	Plant	BS
Thistle, Ashland	*Cirsium ciliolatum*	OR	Plant	BS
Thistle, Cedar Rim	*Cirsium aridum*	WY	Plant	BS
Thistle, Compact Cobwebby	*Cirsium occidentale* var. *compactum*	CA	Plant	BS
Thistle, La Graciosa	*Cirsium loncholepis*	CA	Plant	FE
Thislte, Long-styled	*Cirsium longistylum*	MT	Plant	BS
Thistle, Mount Hamilton	*Cirsium fontinale* var. *campylon*	CA	Plant	BS
Thistle, Ownbey's	*Cirsium ownbeyi*	CO, UT, WY	Plant	BS
Thistle, Pitcher's	*Cirsium pitcheri*	CA	Plant	FT
Thistle, Rocky Mountain	*Cirsium perplexans*	CO	Plant	BS
Thistle, Slough	*Cirsium crassicaule*	CA, WY	Plant	BS
Thistle, Virgin	*Cirsium virginense*	UT	Plant	BS
Thornbush, Seaside	*Kaemefeltia californica*	CA	Plant	BS
Thornmint, San Benito	*Acanthomintha obovata* ssp. *obovata*	CA	Plant	BS
Thornmint, San Diego	*Acanthomintha ilicifolia*	CA	Plant	FT
Thornmint, San Clara	*Acanthomintha lanceolata*	CA	Plant	BS
Thrasher, Bendire's	*Toxostoma bendirei*	CA	Bird	BS
Thrasher, Crissal	*Toxostoma crissale*	NV, UT	Bird	BS
Thrasher, Le Conte's	*Toxostoma lecontei*	CA, NV	Bird	BS
Thrasher, Sage	*Oreoscoptes montanus*	WY	Bird	BS
Thread moss, Slender	*Orthodontium gracile*	CA	Plant	BS
Threads, Comanche Point Layia	*Layia leucopappa*	CA	Plant	BS
Threadstem, Rigid	*Nemacladus rigidus*	ID	Plant	BS
Three Hearts	*Tricardia watsonii*	AZ	Plant	BS
Thrush, Gray-cheeked	*Catharus mimimus*	AK	Bird	BS
Tidy-tips, Munz's	*Layia munzii*	CA	Plant	BS
Tidy-tips, Rayless	*Layia discoidea*	CA	Plant	BS
Tightcoil (Snail), Crater Lake	*Pristiloma arctium crateris*	OR	Snail	BS

Common Name	Scientific Name	State	Class	Status[1]
Titmouse, Juniper	*Baelophus griseus*	NV	Bird	BS
Toad, Amargosa	*Bufo nelsoni*	NV	Amphibian	BS
Toad, Arizona	*Bufo microscaphus microscaphus*	CA, NM, UT	Amphibian	BS
Toad, Arroyo	*Bufo californicus (=microscaphus)*	CA	Amphibian	FE
Toad, Boreal	*Bufo boreas boreas*	CO, ID, WY	Amphibian	C
Toad, Canadian	*Bufo hemiophrys*	MT	Amphibian	BS
Toad, Couch's Spadefoot	*Scaphiopus couchi*	CA	Amphibian	BS
Toad, Southwestern	*Bufo microscaphus*	NV	Amphibian	BS
Toad, Western	*Bufo boreas*	ID	Amphibian	BS
Toad, Woodhouse	*Bufo woodhousii*	ID	Amphibian	BS
Toad, Wyoming	*Bufo baxteri (=hemiophyrs)*	WY	Amphibian	FE
Tonestus, Lone Mountain	*Tonestus graniticus*	NV	Plant	BS
Tortula moss, California	*Tortula californica*	CA	Plant	BS
Topminnow, Gila (including Yaqui Topminnow)	*Poeciliopsis occidentalis*	AZ, NM	Fish	FE
Topminnow, Plains	*Fundulus sciadicus*	CO	Fish	BS
Tortoise, Desert (Mojave Desert Tortoise)	*Gopherus agassizii*	AZ, CA, NV, UT	Reptile	FT
Towhee, Inyo California	*Pipilo crissalis eremophilus*	CA	Bird	FT
Townsend-daisy, Cushion	*Townsendia condensata*	MT	Plant	BS
Townsend-daisy, Gypsum	*Townsendia gypsophila*	NM	Plant	BS
Townsend-daisy, Scapose	*Townsendia scapigera*	ID	Plant	BS
Townsend-daisy, Showy	*Townsendia florifera*	MT	Plant	BS
Townsendia, Last Chance	*Townsendia aprica*	UT	Plant	FT
Treefrog, Canyon	*Hyla arenicolor*	CO, WY	Amphibian	BS
Triquetrella moss, California	*Triquetrella californica*	OR	Plant	BS
Triteleia, Leach's	*Triteleia hendersonii* var. *leachiae*	OR	Plant	BS
Trout, Bonneville Cutthroat	*Oncorhynchus clarki utah*	ID, NV, UT, WY	Fish	BS
Trout, Bull	*Salvelinus confluentus*	ID, MT, NV, OR	Fish	FT
Trout, Coastal Cutthroat (Columbia River Trout)	*Oncorhynchus clarki clarki*	OR	Fish	BS
Trout, Colorado River Cutthroat	*Oncorhynchus clarki pleuriticus*	CO, UT, WY	Fish	BS
Trout, Fine-spotted Snake River Cutthroat	*Oncorhynchus clarki* spp.	WY	Fish	BS
Trout, Gila	*Oncorhynchus gilae*	AZ, NM	Fish	FE
Trout, Great Basin Redband	*Oncorhynchus mykiss*	OR	Fish	BS
Trout, Greenback Cutthroat	*Oncorhynchus clarki stomias*	CO	Fish	FT
Trout, Inland Redband (Jenny Creek Trout)	*Oncorhynchus mykiss gairdneri*	NV, OR	Fish	BS
Trout, Lahontan Cutthroat	*Oncorhynchus clarki henshawi*	CA, CO, NV, OR, UT	Fish	FT
Trout, Redband	*Oncorhynchus mykiss gibbsi*	ID	Fish	BS
Trout, Rio Grande Cutthroat	*Oncorhynchus clarki virginalis*	CO	Fish	BS
Trout, Westslope Cutthroat	*Oncorhynchus clarki lewisi*	ID, MT, OR	Fish	BS
Trout, Yellowstone Cutthroat	*Oncorhynchus clarki bouvieri*	ID, MT, NV, WY	Fish	BS
Truffle Eater	*Cordyceps ophioglossoides*	CA	Fungi	BS
Truffle, Hypogeous	*Choiromyces venosus*	CA	Fungi	BS

Common Name	Scientific Name	State	Class	Status[1]
Tryonia, Amargosa	*Tryonia variegata*	NV	Snail	BS
Tryonia, Grated	*Tryonia clathrata*	NV	Snail	BS
Tuctoria, Greene's	*Tuctoria greenei*	CA	Plant	FE
Tumble-mustard, Long Valley	*Thelypodiopsis ambigua* var. *erecta*	UT	Plant	BS
Turk's Head Cactus, Nichol's	*Echinocactus horizonthalonius* var. *nicholii*	AZ	Plant	FE
Turtle, Northwestern Pond	*Clemmys marmorata marmorata*	OR	Reptile	BS
Turtle, Painted	*Chrysemys picta*	OR	Reptile	BS
Turtle, Snapping	*Chelydra serpentina*	MT, UT	Reptile	BS
Turtle, Sonoyta Mud Turtle	*Kinosteron sonoriense longifemorale*	AZ	Reptile	C
Turtle, Southwestern Pond	*Clemmys marmorata pallida*	CA	Reptile	BS
Turtle, Spiny Softshell	*Trionyx spiniferus*	MT	Reptile	BS
Twayblade, Northern	*Listera borealis*	CO	Plant	BS
Twinpod, Dorn's	*Physaria dornii*	WY	Plant	BS
Twinpod, Double	*Physaria brassicoides*	MT	Plant	BS
Twinpod, Dudley Bluffs	*Physaria obcordata*	CO	Plant	FT
Twinpod, Rocky Mountain	*Physaria saximontana* var. *saximontana*	WY	Plant	BS
Twinpod, Salmon	*Physaria didymocarpa* var. *lyrata*	ID, MT	Plant	BS
Twinpod, Tufted	*Physaria condensata*	WY	Plant	BS
Unicorn-plant, Dune	*Proboscidea sabulosa*	NM	Plant	BS
Venus' Looking-glass, False	*Legenere limosa*	CA	Plant	BS
Vervain, Red Hills	*Verbena californica*	CA	Plant	FT
Vetchling, Grimes	*Lathyrus grimesii*	NV	Plant	BS
Violet, Rock	*Viola lithion*	NV	Plant	BS
Violet, Western (Bog Violet)	*Viola lanceolata* ssp. *occidentalis*	OR	Plant	BS
Vireo, Bell's	*Vireo bellii*	NM	Bird	BS
Vireo, Gray	*Vireo vicinior*	CA, NV	Bird	BS
Vireo, Least Bell's	*Vireo bellii pusillus*	CA	Bird	FE
Vole, Amargosa	*Microtus californicus scirpensis*	CA	Mammal	FE
Vole, Ash Meadows Montane	*Microtus montanus nevadensis*	NV	Mammal	BS
Vole, Hualapai Mexican	*Microtus mexicanus hualpaiensis*	AZ	Mammal	FE
Vole, Mexican	*Microtus mexicanus*	UT	Mammal	BS
Vole, Pahranagat Valley Montane	*Microtus montanus fucosus*	NV	Mammal	BS
Vole, Virgin River Montane	*Microtus montanus rivularis*	UT	Mammal	BS
Wafer-Parsnip, Evert's	*Cymopterus evertii*	WY	Plant	BS
Wafer-Parsnip, William's	*Cymopterus williamsii*	WY	Plant	BS
Wallflower, Coast	*Erysimum ammophilum*	CA	Plant	BS
Wallflower, Menzies'	*Erysimum menziesii* ssp. *eurekense*	CA	Plant	FE
Warbler, Blackpoll	*Dendroica striata*	AK	Bird	BS
Warbler, Lucy's	*Vermivora luciae*	NV	Bird	BS
Warbler, Townsend's	*Denroica townsendi*	AK	Bird	BS
Warbler, Virginia's	*Vermivora virginiae*	ID	Bird	BS
Waterhemlock, Bulb-bearing	*Cicuta bulbifera*	ID	Plant	BS
Water-marigold, Beck's	*Megalodonta beckii* var. *beckii*	MT	Plant	BS
Water-starwort, The Dalles	*Callitriche fassettii*	OR	Plant	BS
Water-umbel, Huachuca	*Lilaeopsis schaffneriana* var. *recurva*	AZ	Plant	FE
Waterweed, Long Sheath	*Elodea bifoliata*	MT	Plant	BS
Water-willow, Wright's	*Justica wrightii*	NM	Plant	BS
Wavewing, Greeley's	*Cymopterus acaulis* var. *greeleyorum*	OR	Plant	BS
Waxflower; Jamesia, Four Petal	*Jamesia tetrapetala*	NV, UT	Plant	BS
Weevil, Rulien's Miloderes	*Miloderes* sp.	NV	Insect	BS

Common Name	Scientific Name	State	Class	Status[1]
Western Rosinweed, Butte County	*Calycadenia oppositifolia*	CA	Plant	BS
Western Rosinweed, Dwarf	*Calycadenia villosa*	CA	Plant	BS
Western Rosinweed, Hoover's	*Calycadenia hooveri*	CA	Plant	BS
Whale, Blue	*Balaenoptera musculus*	OR	Mammal	FE
Whale, Bowhead	*Balaena mysticetus*	AK	Mammal	FE
Whale, Finback	*Balaenoptera physalus*	AK	Mammal	FE
Whale, Humpback	*Megaptera novaeangliae*	AK, OR	Mammal	FE
Whiptail, Canyon Spotted	*Cnemidophorus burti*	AZ, NM	Reptile	BS
Whiptail, Gray Checkered	*Cnemidophorus dixoni*	NM	Reptile	BS
Whiptail, Plateau Striped	*Cnemidophorus velox*	UT	Reptile	BS
Whitefish, Bear Lake	*Prosopium abyssicola*	ID	Fish	BS
Whitefish, Pygmy	*Prosopium coulteri*	OR	Fish	BS
Whitlow-grass, Aleutian	*Draba aleutica*	AK	Plant	BS
Whitlow-grass, Howell's	*Draba howellii*	OR	Plant	BS
Whitlow-grass, Ogilve Mountains	*Draba ogilviensis*	AK	Plant	BS
Whitlow-grass, Standley	*Draba standleyi*	NM	Plant	BS
Whitlow-grass, Tundra	*Draba juvenillis*	AK	Plant	BS
Whtilow-grass, Murray's	*Draba murrayi*	AK	Plant	BS
Wild Ginger, Green-flowered	*Asarum caudatum* var. *viridiflorum*	OR	Plant	BS
Wild-rye, Sand	*Elymus flavescens*	MT	Plant	BS
Wild-rye, Sand	*Leymus flavescens*	MT	Plant	BS
Willow, Autumn	*Salix serissima*	CO	Plant	BS
Willow, False Mountain	*Salix pseudomonticola*	ID	Plant	BS
Willow, Hoary	*Salix candida*	CO, ID	Plant	BS
Willow, Low Blueberry	*Salix myrtillifolia*	CO, NM	Plant	BS
Willow, Netleaf	*Salix reticulata* ssp. *glabellicarpa*	AK	Plant	BS
Willow, Soft-leaved	*Salix sessilifolia*	OR	Plant	BS
Willow-herb, Nevada	*Epilobium nevadense*	NV, UT	Plant	BS
Wintergreen, White-veined	*Pyrola picta*	SD	Plant	BS
Wirelettuce, Malheur	*Stephanomeria malheurensis*	OR	Plant	FE
Wire-lettuce, Schott	*Stephanomeria schottii*	AZ	Plant	BS
Wolf, Gray	*Canis lupus*	AZ, CO, NM, NV, WY	Mammal	FE
Wolf, Gray	*Canis lupus*	ID	Mammal	FE, XN
Wolf, Gray	*Canis lupus*	MT, OR, UT	Mammal	FT
Wolf, Mexican Gray	*Canis lupus baileyi*	NM, AZ	Mammal	FE, XE
Wolverine, North American	*Gulo gulo luscus*	ID, UT	Mammal	BS
Wood-fern, Aravaipa	*Thelypteris puberula sonorensis*	AZ	Plant	BS
Woodpecker, Black-backed	*Picoides arcticus*	MT, OR	Bird	BS
Woodpecker, Hairy	*Picoides villosus*	MT	Bird	BS
Woodpecker, Lewis'	*Melanerpes lewis*	ID, NV, OR, UT	Bird	BS
Woodpecker, Red-cockaded	*Picoides borealis*	NM	Bird	FE
Woodpecker, Three-toed	*Picoides tridactylus*	MT, OR, UT	Bird	BS
Woodpecker, White-headed	*Picoides ablolarvatus*	ID, OR	Bird	BS
Woodrat, Riparian (San Joaquin Valley Woodrat)	*Neotoma fuscipes riparia*	CA	Mammal	FE
Woodrat, Stephen's	*Neotoma stepheni*	UT	Mammal	BS
Woodrat, White Sands	*Neotoma micropus leucophaea*	NM	Mammal	BS
Woodsage, American	*Teucrium canadense* var. *occidentale*	ID	Plant	BS
Woody-aster, Orcutt's	*Xylorhiza orcuttii*	CA	Plant	BS

Common Name	Scientific Name	State	Class	Status[1]
Woolly-heads, Dwarf	*Psilocarphus brevissimus*	MT	Plant	BS
Wooly-star, Brandeegee's	*Eriastrum brandegeeae*	CA	Plant	BS
Woolly-star, Hoover's	*Eriastrum hooveri*	CA	Plant	FT
Woolly-star, Santa Ana River	*Eriastrum densifolium*	CA	Plant	FE
Woolly-star, Yellow-flowered	*Eriastrum luteum*	CA	Plant	BS
Woolly-sunflower, Barstow	*Eriophyllum mohavense*	CA	Plant	BS
Woolly-sunflower, Fort Tejon	*Eriophyllum lanatum* var. *hallii*	CA	Plant	BS
Wooly-threads, San Joaquin	*Lembertia congdonii*	CA	Plant	FE
Wormwood, Aleutian	*Artemisia aleutica*	AK	Plant	BS
Wormwood, Mystery	*Artemisia biennis* var. *diffusa*	WY	Plant	BS
Wormwood, Northern	*Artemisia campestris* var. *wormskioldii*	OR	Plant	C
Wormwood, Purple	*Artemisia globularia*	AK	Plant	BS
Wormwood, Yellow-ball	*Artemisia senjavinensis*	AK	Plant	BS
Woundfin	*Plagopterus argentissimus*	AZ, NM, NV, UT	Fish	FE
Yampah, Red-rooted	*Perideridia erythrorhiza*	OR	Plant	BS
Yarrow, Cusick's False	*Chaenactis cusickii*	ID	Plant	BS
Yellow Cress, Columbian (Columbia Cress)	*Rorippa columbiae*	CA, OR, WA	Plant	BS
Yellow Cress, Persistant Sepal	*Rorippa calycina*	MT, WY	Plant	BS
Yellow Cress, Tahoe	*Rorippa subumbellata*	CA, NV	Plant	C
Yellowhead, Desert	*Yermo xanthocephalus*	WY	Plant	FT
Yellowthroat, Common	*Geothlypis trichas*	UT	Bird	BS

[1] BS = BLM sensitive species; DM = Delisted species that has recovered and will be monitored for 5 years; C = Candidate species for listing under the ESA; EmE = Emergency endangered species listing; FE = Federal endangered species; FT = Federal threatened species; PE = Proposed for listing as an endangered species; PT = Proposed for listing as a threatened species; XE = Experimental population, essential; and XN = Experimental population, nonessential.

[2] ESU = Evolutionary Significant Unit.

U.S. GOVERNMENT PRINTING OFFICE: 2007 — 660-087 / 11004 Region No. 8

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACEC	Area of critical environmental concern
a.i.	Active ingredient
AML	Appropriate management level
AMP	Allotment management plan
ANILCA	Alaska National Interest Lands Conservation Act
APHIS	Animal and Plant Health Inspection Service
ATV	All-terrain vehicle
AUM	Animal use months
BA	Biological assessment
BAR	Burned area rehabilitation
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
BMP	Best management practice
BP	Before the present
BPA	Bonneville Power Administration
CALPUFF	California Puff
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CO	Carbon monoxide
CWMA	Cooperative weed management area
CWPP	Community wildfire protection plan
EA	Environmental assessment
EFR	Emergency fire rehabilitation
EIS	Environmental impact statement
EO	Executive order
ERA	Ecological risk assessment
ERMA	Extensive recreation management area
ESA	Endangered Species Act
ES	Emergency stabilization
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLPMA	Federal Land Policy and Management Act
ft	Foot/feet
FMP	Fire management plan
FORVIS	Forest Vegetation Information System
FRCC	Fire regime condition class
FY	Fiscal year
GAO	U.S. Government Accounting Office
GBRI	Great Basin Restoration Initiative
GCVTC	Grand Canyon Visibility and Transport Commission
HFRA	Healthy Forests Restoration Act
HFR	Hazardous fuels reduction
HHRA	Human health risk assessment
HMA	Herd management area
INFISH	Inland Native Fish Strategy
IVM	Integrated vegetation management
IWM	Integrated weed management
L	Liter
LANDFIRE	Landscape Fire and Resource Management Planning Tools Project
lb(s)	Pound(s)
LUP	Land use plan
MFP	Management framework plan
mg/L	Milligrams per Liter
mi	Mile(s)
mi^2	Square mile(s)
MOU	Memorandum of understanding
mph	Miles per hour
N	Nitrogen
NA	Not applicable or not available
NAAQS	National Ambient Air Quality Standard
NAPIS	National Agricultural Pest Information System
NAWQA	National Water Quality Assessment
NCIPC	National Center for Injury Prevention and Control
NEPA	National Environmental Policy Act
NCHS	National Center for Health Statistics
NHPA	National Historic Preservation Act
NMFS	National Oceanic and Atmospheric Administration National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPMP	Native Plant Materials Program
NRHP	National Register of Historic Places
NIOSH	National Institute for Occupational Safety and Health
NLCS	National Landscape Conservation System
NO_2	Nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NWCG	National Wildfire Coordinating Group
NWIS	National Water Information System
O_3	Ozone
O&C	Oregon and California
OHV	Off-highway vehicle
Pb	Lead
PEIS	Programmatic environmental impact statement
PER	Programmatic environmental report
PM	Particulate matter

$PM_{2.5}$	Fine particulate matter less than 2.5 microns in diameter
PM_{10}	Particulate matter less than 10 microns in diameter
ppm	Parts per million
ppt	Parts per thousand
PSD	Prevention of significant deterioration
RCRA	Resource Conservation and Recovery Act of 1976
RMP	Resource management plan
ROD	Record of Decision
ROW	Rights-of-way
SERA	Syracuse Environmental Research Associates, Inc.
SHPO	State Historic Preservation Officer
SIP	State implementation plan
SMP	Smoke management plan
SRMA	Special recreation management area
PUP	Pesticide use proposal
SOCATS	Southern Oregon Citizens Against Toxic Sprays
SO_2	Sulfur dioxide
SOP	Standard operating procedure
TDS	Total dissolved solids
TES	Threatened, endangered, and sensitive
TSP	Total suspended particles
TSS	Total suspended solids
TIP	Tribal implementation plan
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile organic compounds
VRM	Visual resource management
WFIP	Wildland fire implementation plan
WFLC	Wildland Fire Leadership Council
WRAP	Western Regional Air Partnership
WSA	Wilderness study area
WSR	Wild and scenic river
WSRA	Wild and Scenic Rivers Act
WUI	Wildlands urban interface
$<$	Less than
$\mu g/m^3$	Micrograms per cubic meter
°F	Degrees Fahrenheit
2,4-D	2,4 dichlorophenoxyacetic acid
2,4-DP	Dichlorprop

The Bureau of Land Management *Today*

Our Vision To enhance the quality of life for all citizens through the balanced stewardship of America's public lands and resources.

Our Mission To sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

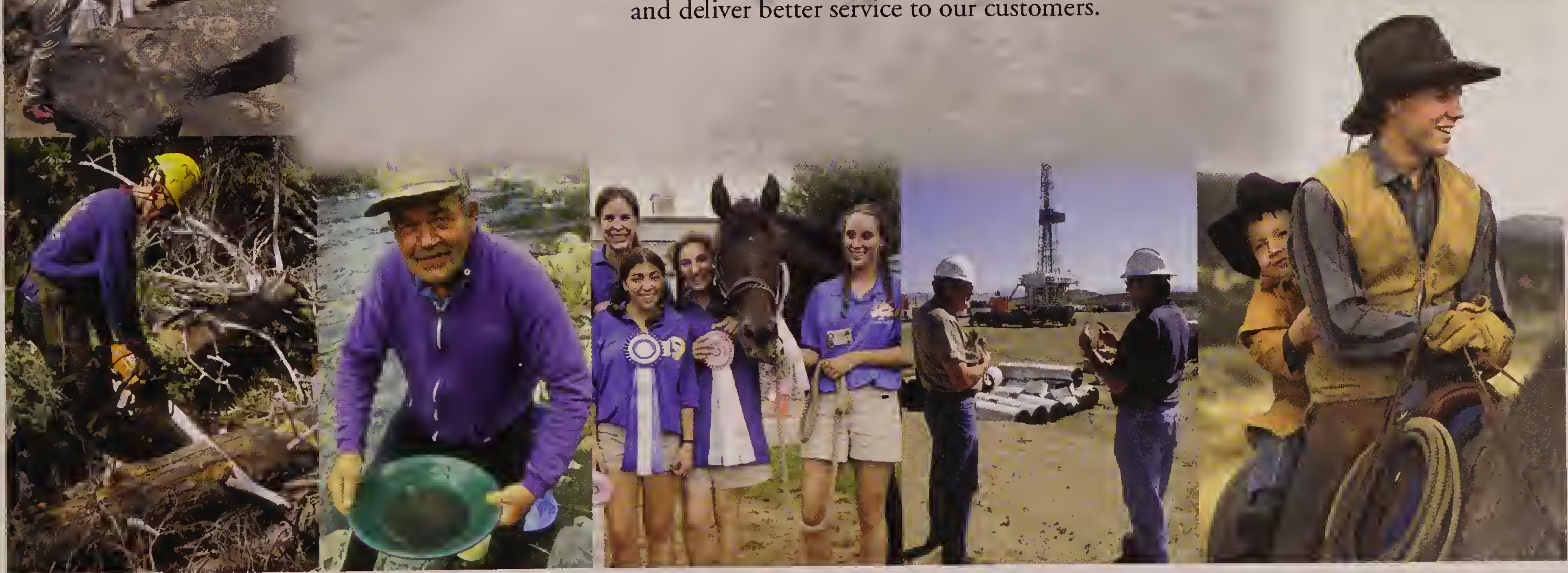
Our Values To serve with honesty, integrity, accountability, respect, courage, and commitment to make a difference.

Our Priorities To improve the health and productivity of the land to support the BLM multiple-use mission.

To cultivate community-based conservation, citizen-centered stewardship, and partnership through consultation, cooperation, and communication.

To respect, value, and support our employees, giving them resources and opportunities to succeed.

To pursue excellence in business practices, improve accountability to our stakeholders, and deliver better service to our customers.



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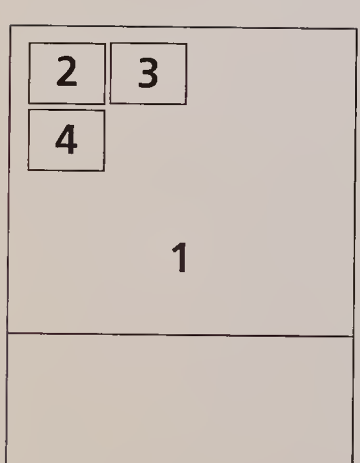

Cover Photos and Photo Credits

1. Arrowleaf balsamroot (*Balsamorhiza sagittata*) in bloom near Elko, Nevada (courtesy of Stan White, Bureau of Land Management Volunteer)
2. Chainsaw cutting (courtesy of Kari Greer, National Interagency Fire Center)
3. Prescribed fire (courtesy of Bryan Day, National Interagency Fire Center)
4. Sheep removing leafy spurge (*Euphorbia esula*) (courtesy of Team Leafy Spurge)

Covers, spines, and CD labels layout and design provided by the BLM National Science and Technology Center.

BLM/WO/GI-07/010+6711